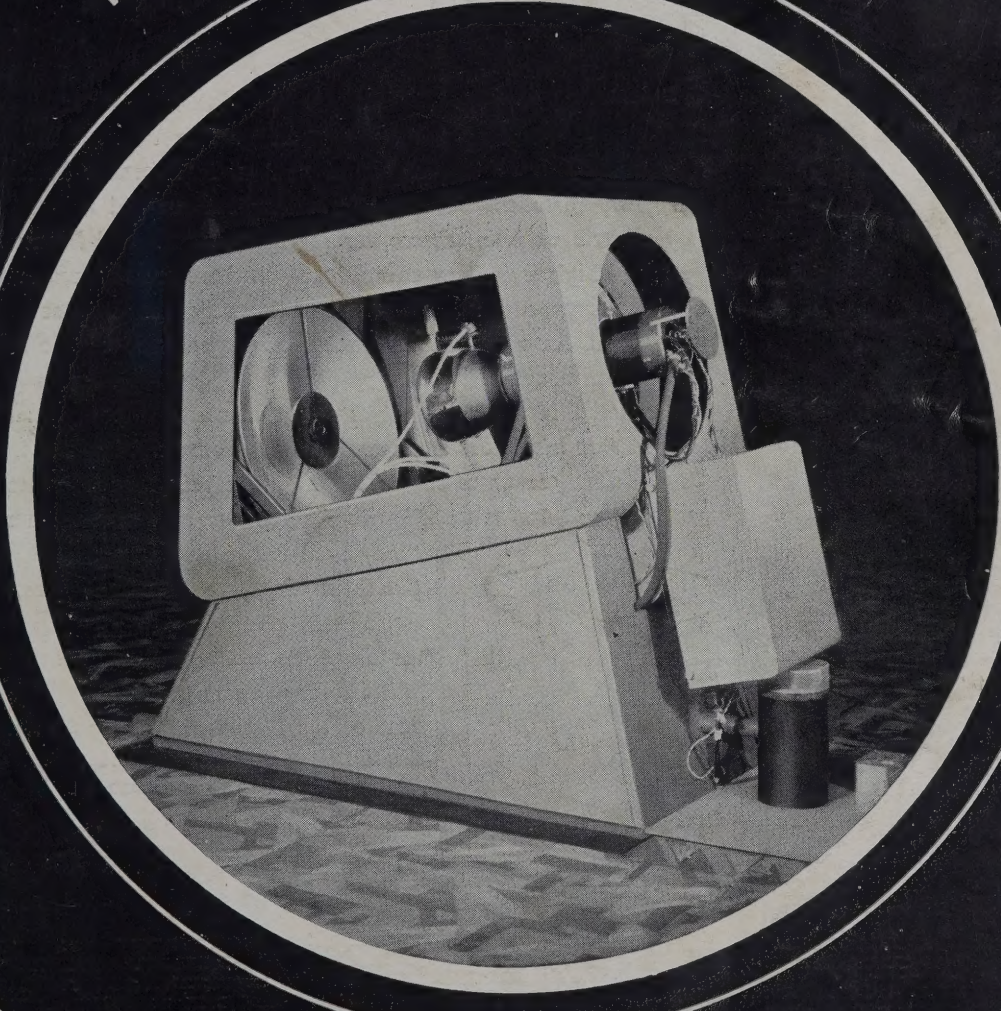
Wireless World

RADIO AND ELECTRONICS

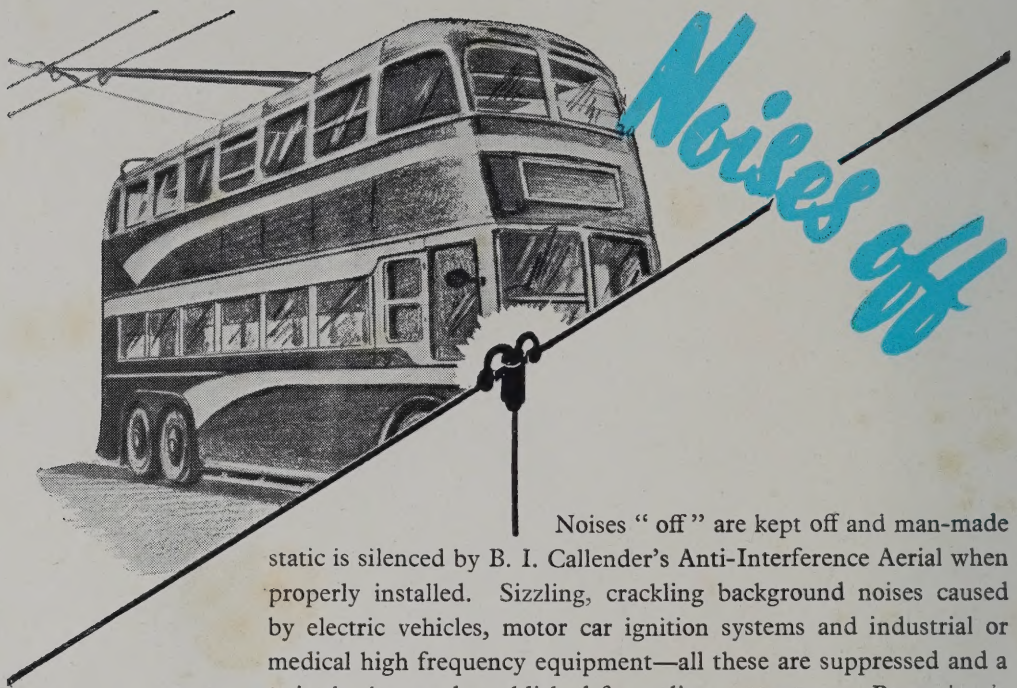


JAN. 1949

2/-

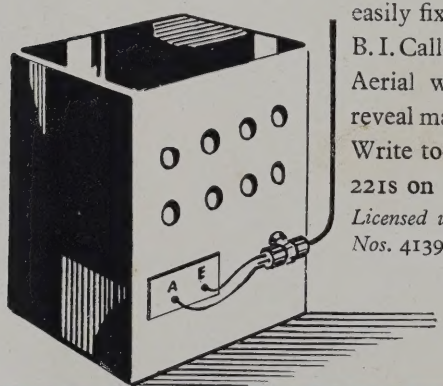
Vol. LV. No. 1

IN THIS ISSUE : MEASUREMENT OF "Q"



Noises " off " are kept off and man-made static is silenced by B. I. Callender's Anti-Interference Aerial when properly installed. Sizzling, crackling background noises caused by electric vehicles, motor car ignition systems and industrial or medical high frequency equipment—all these are suppressed and a quiet background established for radio programmes. Reception is improved, for a maximum number of programmes can be enjoyed on all wavelengths.

The aerial is a 60 ft. polyethylene insulated dipole type, with suspension insulators and matching transformer. The 80 ft. down lead is a fully screened coaxial cable with polyethylene plugs moulded to each end and is matched to the receiver by a transformer with easily fixed suction mounting.



B. I. Callender's All-Wave Anti-Interference Aerial will give you better listening and reveal many stations you never heard before. Write to-day for the descriptive folder No. 221S on the Anti-Interference Aerial.

Licensed under Amy Aceves & King, Inc. Patents Nos. 413917, 424239 *and* 491220.

B.I. Callender's *All-Wave* ANTI-INTERFERENCE **AERIAL**

BRITISH INSULATED CALLENDER'S CABLES LIMITED
NORFOLK HOUSE, NORFOLK STREET, LONDON, W.C.2

AVO
REGD. TRADE MARK

Precision
ELECTRICAL TESTING INSTRUMENTS

The "AVO" ELECTRONIC TESTMETER

BRITISH MADE

This instrument, which is an up-to-date example of current instrument practice, has been developed to meet the growing demand for an instrument of laboratory sensitivity built in a robust and portable form, for use in conjunction with electronic and other apparatus where it is imperative that the instrument should present a negligible loading factor upon the circuit under test.

The instrument consists basically of a balanced bridge voltmeter. It incorporates many unique features and a wide set of ranges so that in operation it is as simple to use as a normal multi-range testmeter.

The instrument gives 49 ranges of readings as follows :—

D.C. VOLTS: 2.5mV. to 10,000V.
(Input Resistance 111.1 megohms).
D.C. CURRENT: 0.25μA. to 1 Amp.
(150mV. drop on all ranges).
A.C. VOLTS: 0.1V. to 2,500 V. R.M.S. up to 1 Mc/s. With external diode probe 0.1V. to 250V. up to 200 Mc/s.
A.C. OUTPUT POWER: 5mW. to 5 watts in 6 different load resistances from 5 to 5,000 ohms.
DECIBELS: —10db. to +20db.
CAPACITANCE: .0001μF. to 50μF.
RESISTANCE: 0.2 ohms to 10 megohms.
INSULATION: 0.1 megohm to 1,000 megohms.

The thermionic circuit gives delicate galvanometer sensitivity to a robust moving coil movement. It is almost impossible to damage by overload. The instrument is quickly set up for any of the various tests to be undertaken, a single circuit selector switch automatically removing from the circuit any voltages and controls which are not required for the test in question.

PRICE
£35

Fully descriptive pamphlet available on application.

Sole Proprietors and Manufacturers :—

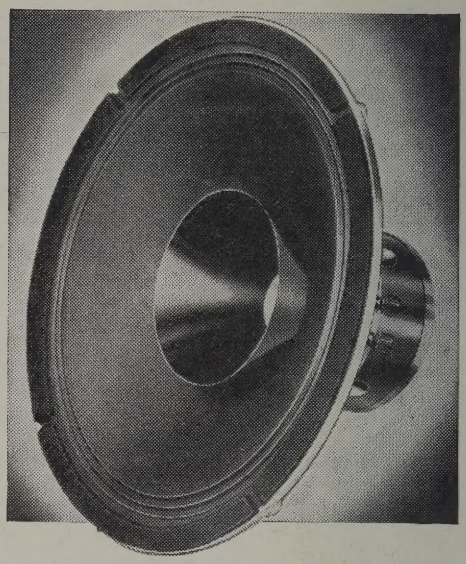
The AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO. LTD.
WINDER HOUSE • DOUGLAS STREET • LONDON • S.W.1 *Telephone: VICTORIA 3404/9*

E.T.M. 3

A

For *High Fidelity* reproduction

GOODMANS *'AXIOM TWELVE'* *Loudspeaker*



This instrument is sufficiently outstanding to arouse the lively appreciation of all High Fidelity enthusiasts. If your equipment can provide a practically faultless output, we have no hesitation in saying that its performance with the Axiom Twelve Loudspeaker will impress you agreeably.

It must be emphasised, however, that the Axiom Twelve is a High Fidelity Reproducer and *must* be used with equipment which has also been specifically designed for this purpose. If the signal includes any distortion, this will be reproduced, possibly with unpleasant aural results. That is why, for general requirements, we still recommend our standard 12" model T2.

FIDELITY EFFICIENCY

SPECIFICATION:—

Frequency Range	40-15,000 c/s.	Flux Density	13,000 gauss.
Fundamental Resonance	55 c/s.	Total Flux	145,000 maxwells.
Voice Coil Impedance	15 ohms.	Power Rating	12 watts peak A.C.
Voice Coil Diameter	1¾".	*Write for fully descriptive Folder D.19.*	

GOODMANS INDUSTRIES, LTD., LANCELOT ROAD, WEMBLEY, MIDDX. *'Phone: Wembley, 1200. Cables: "Goodmans, Wembley 1200."*

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SOUND SERVICE

THE COMPLETE SERVICE FOR SOUND RECORDING AND REPRODUCTION

- ★ Mobile, static and specialised recording units
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- ★★ A development of special interest to users of sapphire and-delicate pick-ups—THE SIMITROL. This is a controlled micro-movement easily fitted for use with any type of pick-up
- ★★★ OUR CDR48A RECORDER UNIT complete and self-contained, measuring only 22in. x 14in. x 13½in., incorporating 7-valve amplifier, recorder unit, light-weight pick-up, speaker and microphone and with many exclusive features, is now ready for early delivery.

Portable Twin Channel Continuous Recording System incorporating CDR48A Recorder/Amplifier DR48A Recorder and EM48A Electronic 4 Channel Mixer

OUR WELL-EQUIPPED WORKSHOPS ARE AVAILABLE FOR THE DEVELOPMENT OF EQUIPMENT TO MEET SPECIAL NEEDS.

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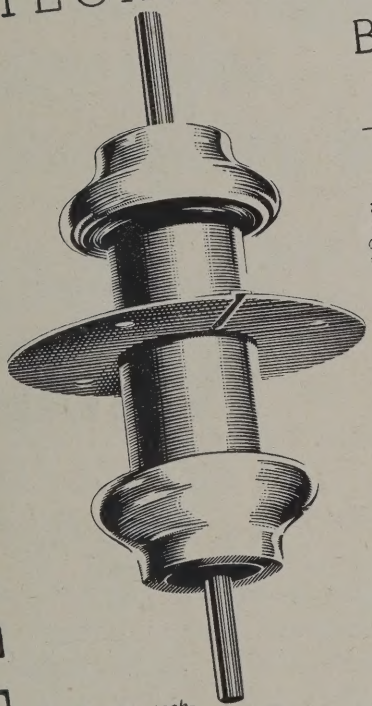
CABLES: Simsale, London. *TELEGRAMS: Simsale, Wesdo, London.* *TELEPHONE: Welbeck 2371 (4 lines).*

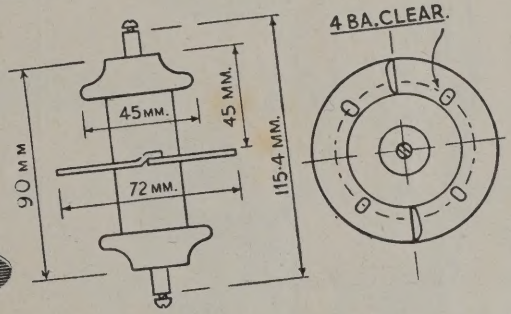
U.I.C

HIGH STABILITY CAPACITORS

TECHNICAL INFORMATION BULLETIN **No 1**



Further technical details furnished on request.



LEAD-THROUGH "HI-LOAD" CAPACITOR

This new Ceramic "Hi-Load" Capacitor has been specially designed as H.T. or Heater By-Pass and Lead-Through Capacitor. Although very small in dimensions the capacitor has a capacitance of 1,000 pF and it is rated at 40 KVA R.F. with a maximum R.F. current of 20 amps. The sturdy rod forming the lead-through connection is capable of handling all normal currents. The high rating also makes the capacitor suitable as a tank capacitor.

UNITED INSULATOR CO. LTD. OAKCROFT RD. TOLWORTH SURBITON SURREY

Telephone: Elmbridge 5241 (6 lines) *Telegrams: Calanel, Surbiton*

The best–

HIGH

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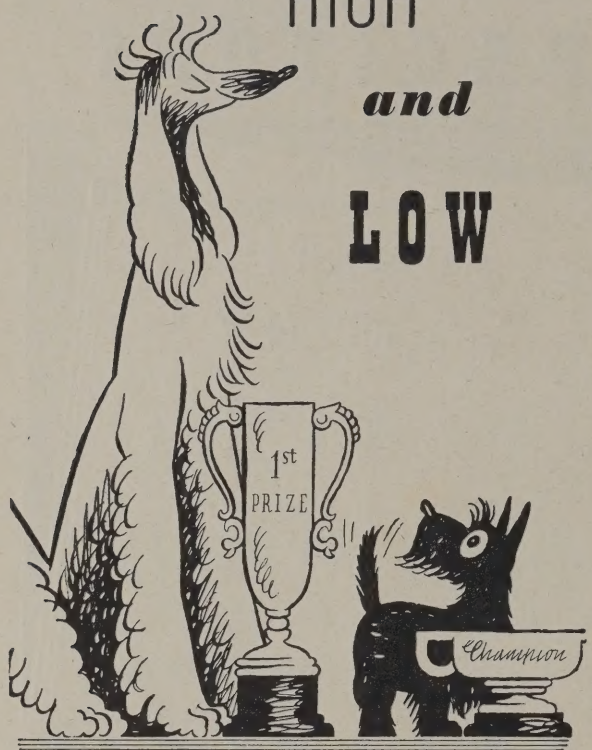
LOW



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H.T. BATTERIES

for better battery radio reception

ISSUED BY THE CHLORIDE ELECTRICAL STORAGE COMPANY LIMITED

E.H.T.

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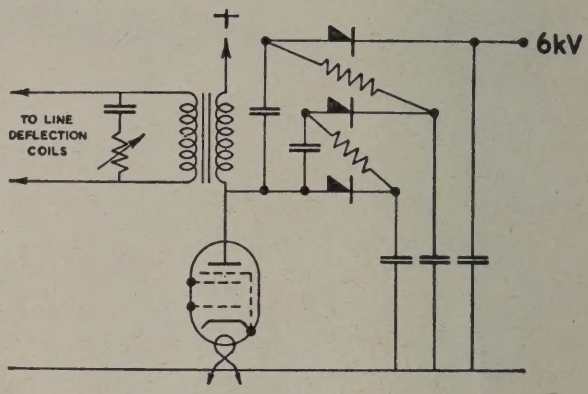

Tripler circuit using

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TYPE 36EHT35 RECTIFIERS

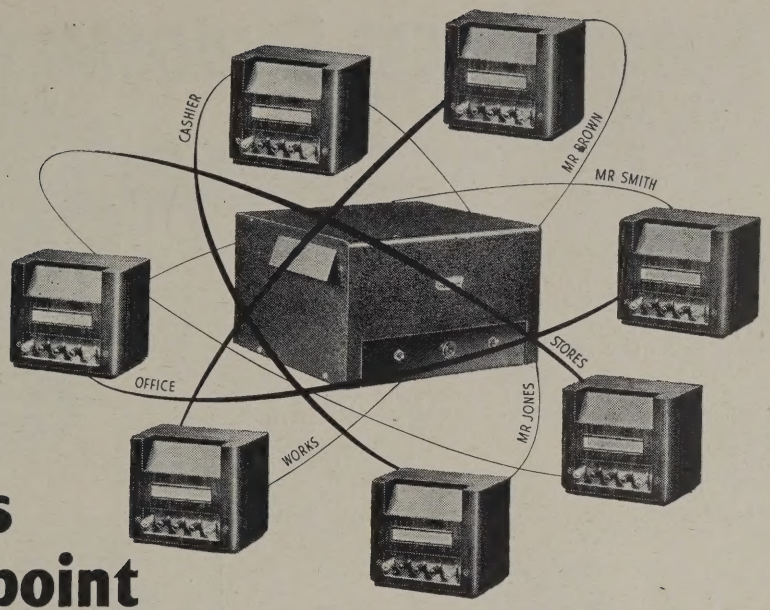
Peak pulse input approximately 2,500V. Output approximately 6kV at 100 micro-amperes.

Simple . . . efficient . . . and reliable

Write for data sheet No. 60, to Dept. W.W.1

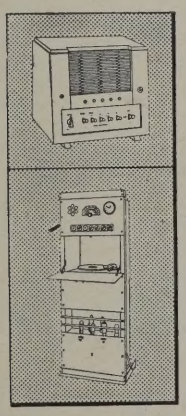
WESTINGHOUSE BRAKE & SIGNAL CO., LTD.

82 YORK WAY, KING'S CROSS, LONDON, N.1



Make calls from any point with the Hadley MULTICOM . . .

The first system of its kind to provide complete loudspeaker intercommunication between all points. Up to seven Departments are instantly in touch with one another by the flick of a switch. All stations are identical. Priority of call is provided on the principal unit.



Other Hadley Products

THE HADLEY INTERCOMMUNICATOR
designed for personal communication between master unit and any or all of the sub-stations and also incorporates the novel feature of a desk radio which can be relayed to the sub-stations. An inexpensive aid to efficiency.

THE HADLEY INDUSTRIAL UNIT
proved to be well in advance of any similar equipment. Provides all facilities for 'Staff Location,' 'Music for the Workers,' 'Time Signals,' etc.

All Hadley Equipments are available on Cash Purchase or Rental Maintenance terms.

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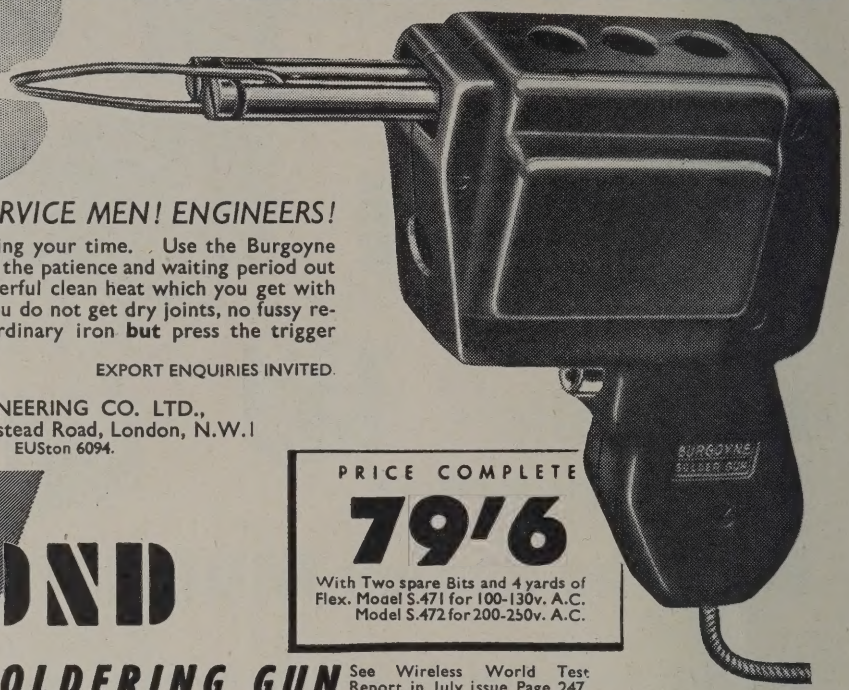
Phone: BEArwood 2575/6 BEARWOOD ROAD, SMETHWICK, STAFFS.

PATIENCE NO LONGER A VIRTUE

WHERE *SOLDERING'S* CONCERNED



AMATEURS! SERVICE MEN! ENGINEERS!

Don't be patient. You are wasting your time. Use the Burgoyne Seven Second Solder Gun and take the patience and waiting period out of your soldering. The wonderful clean heat which you get with the Solder Gun will ensure that you do not get dry joints, no fussy re-tinning required. Use like an ordinary iron **but** press the trigger and solder immediately.

Send for fully descriptive folder free. EXPORT ENQUIRIES INVITED.

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PRICE COMPLETE
79/6
With Two spare Bits and 4 yards of Flex. Model S.471 for 100-130v. A.C. Model S.472 for 200-250v. A.C.

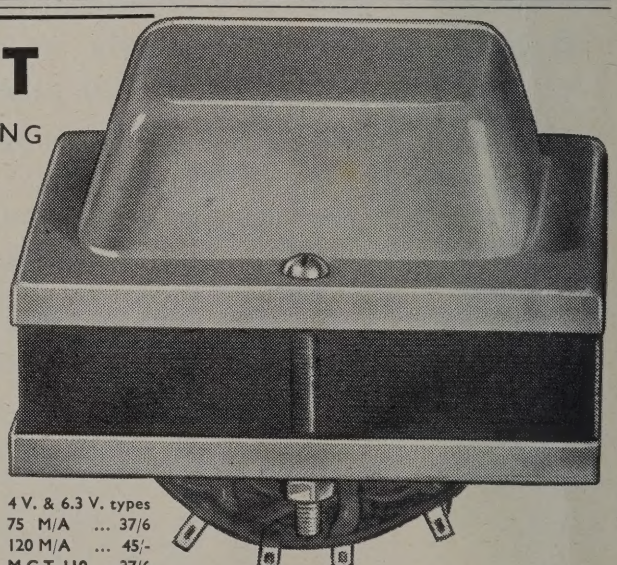
SEVEN SECOND
INDUCTION SOLDERING GUN

See Wireless World Test Report in July issue Page 247.

BUILT TO LAST

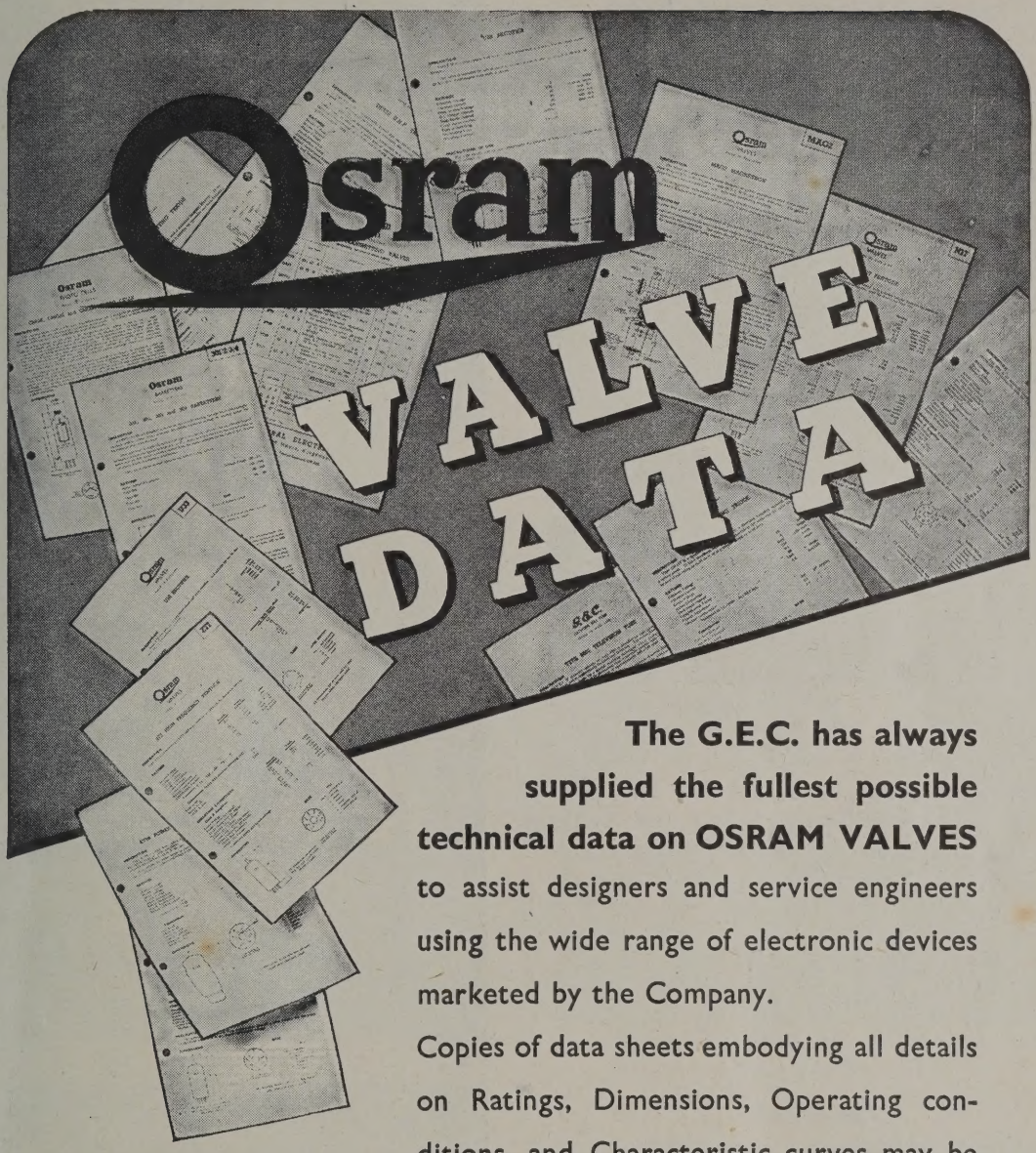
M.C.T. RANGE · CHASSIS MOUNTING
FULLY IMPREGNATED

TYPE	USE	PRIMARY	SECONDARY
M.C.T.100	Mains Transformer	0-200-230-250 v. 40-100 Cps.	300-0-300 v. 75 m/a 4 v. 4 amps. 4 v. 2 amps.
M.C.T.101	Mains Transformer	0-200-230-250 v. 40-100 Cps.	300-0-300 v. 75 m/a. 6.3 v. 3 amps. 5 v. 2 amps.
M.C.T.110	Auto Transformer	0-100-110-200-230-250 volts 40-100 Cps. 100 w.	
M.C.T.120	Mains Transformer	0-200-230-250 v. 40-100 Cps.	350-0-350 v. 75 m/a. 4 v. 4 amps. 4 v. 2 amps.
M.C.T.121	Mains Transformer	0-200-230-250 v. 40-100 Cps.	350-0-350 v. 75 m/a. 6.3 v. 3 amps. 5 v. 2 amps.
M.C.T.124	Mains Transformer	0-200-230-250 v. 40-100 Cps.	350-0-350 v. 120 m/a. 4 v. 4.5 amps. 4 v. 2 amps.
M.C.T.125	Mains Transformer	0-200-230-250 v. 40-100 Cps.	350-0-350 v. 120 m/a. 6.3 v. 3 amps. 5 v. 2 amps.



4 V. & 6.3 V. types
75 M/A ... 37/6
120 M/A ... 45/-
M.C.T. 110 ... 37/6

RM MAINS TRANSFORMERS
R.M. ELECTRIC LTD.,
TEAM VALLEY,
GATESHEAD, 11



The G.E.C. has always supplied the fullest possible technical data on OSRAM VALVES to assist designers and service engineers using the wide range of electronic devices marketed by the Company.

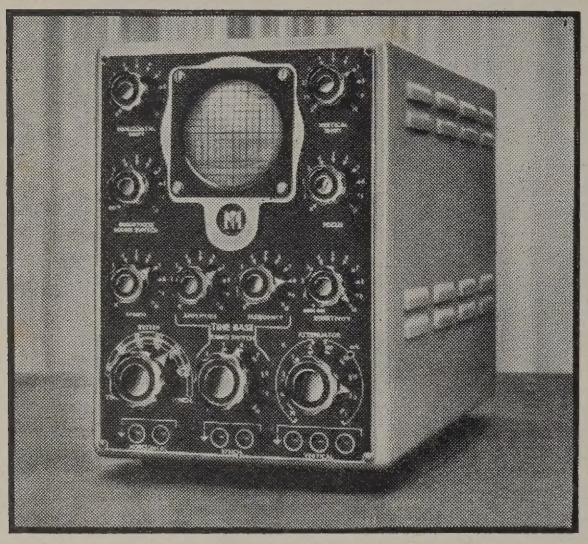
Copies of data sheets embodying all details on Ratings, Dimensions, Operating conditions, and Characteristic curves may be had on specification of type required to the

OSRAM VALVE TECHNICAL DEPT. *Magnet House, Kingsway, W.C.2*

Osram PHOTO CELLS G.E.C. CATHODE RAY TUBES Osram VALVES

THE GENERAL ELECTRIC CO. LTD., MAGNET HOUSE, KINGSWAY, W.C.2.

Measurement by Mullard



Mullard Oscillograph type E.800/1

The name of Mullard has for long been connected with cathode ray oscillographs, and their experience in this field is unequalled. Mullard cathode ray tubes, Mullard valves and Mullard circuitry have been combined to produce the accepted standard oscillograph.

Type E.800/1

Time base frequency 0.25—16,000 c/s.
Amplifier response (2 dB loss) 0.1—40,000 c/s.
Amplifier sensitivity (Max. Gain) 1 mV.rms/cm.
Delivery—Ex stock.

Type E.805

Time base frequency 5 c/s—150 Kc/s.
Amplifier response (3 dB loss) 2 c/s—2 Mc/s.
Amplifier sensitivity (Max. Gain) 5 mV. rms/cm.
Delivery—Ex stock.

Mullard

Mullard Electronic Products Ltd.

Electronic Equipment Division

ABOYNE WORKS, ABOYNE ROAD, LONDON, S.W.17.

(MI.276)

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THE NO Distortion TELEVISION LENS

Enlarges the Picture for ALL to See

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The world acknowledges British leadership in the television field. An important factor contributing to this supremacy is the consistent high standard, of quality and performance, of the components used in television apparatus. Dubilier Nitrogol Capacitors are produced with scrupulous regard to the fact that in all television circuits there are positions where only capacitors of the highest technical merit and proven reliability will suffice.

In such radio and electronic applications as undersea cable repeaters, radar apparatus, high quality amplifiers, and industrial electronic devices, the use of outstanding capacitors is a prime necessity ; here, too, experienced engineers specify Nitrogol Capacitors.

We shall be pleased to forward full technical details of these Capacitors upon request, and our technicians, backed by a competent laboratory organisation, are always ready to advise upon their use.

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CONDENSER CO. (1925) LTD.

MAKERS OF THE WORLD'S FINEST CAPACITORS

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'Phone : Acorn 2241 (5 lines) 'Grams : Hilvoltcon, Phone London. Cables : Hilvoltcon, London. Marconi International Code D21

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SUB-STANDARD Signal GENERATOR

TYPE B4

Model A 100 Kc/s -70 Mc/s

Model B 30 Kc/s -30 Mc/s

Accuracy ± 1db

Features—

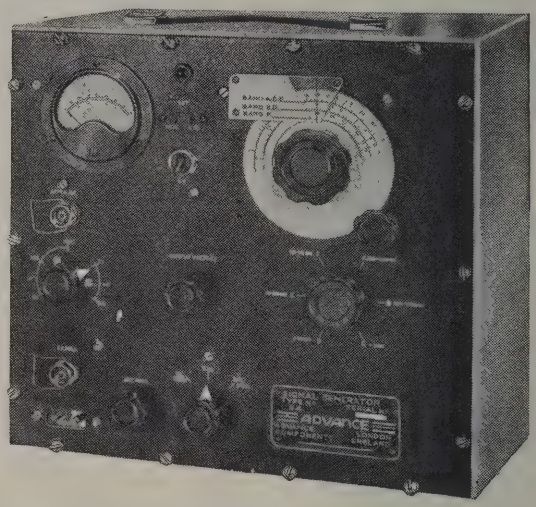
CALIBRATION ACCURACY: ± 1% Directly Calibrated.
OUTPUT VOLTAGE: 1μV—150 mV up to 30 Mc/s. 1μV—100 mV above 30 Mc/s Monitored by crystal voltmeter
OUTPUT IMPEDANCE: 75 ohms, terminated by 75 ohms terminating pad type TP.1A, providing impedance of 37 ohms, 10 ohms, and 10 ohms standard dummy aerial.
MODULATION: Internal: 400 c/s. 0-50% External: 100-10,000 c/s ± 6db, 0-80%.
AUDIO-OUTPUT: 0-15 volts at approximately 400 c/s into a load not less than 5,000 ohms.
R.F. LEAKAGE: Negligible—less than 1μV.
POWER SUPPLY: 110-210-230-250 volts, 40-100 c/s, 22 watts.
DIMENSIONS: 13ins. x 12ins. x 6ins. deep.
WEIGHT: 25 lbs.

Send for illustrated brochure giving full Specification.

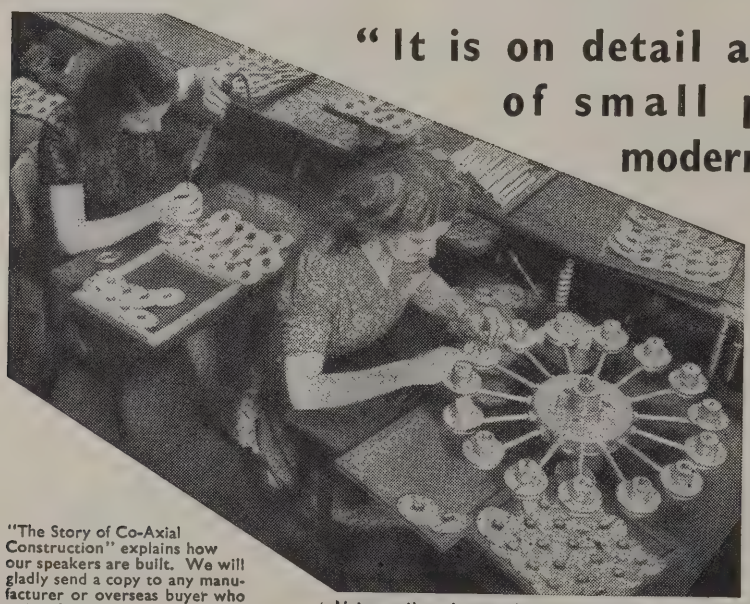
Covering all Television Ranges

Model A. 100 Kc/s to 70 Mc/s in 6 Bands
Model B. 30 Kc/s to 30 Mc/s in 6 Bands

- Negligible Stray Radiation.
- Output accuracy 1db.
- Directly Calibrated.



ADVANCE COMPONENTS LTD., Back Rd., Shernhall St., Walthamstow, E.17. *'Phone: LARkswood 4366-7-*



"The Story of Co-Axial Construction" explains how our speakers are built. We will gladly send a copy to any manufacturer or overseas buyer who writes for one.

Voice coil and centering member sub-assembly.

"It is on detail and care in design of small points that the modern set stands or falls"

"Radio Times," Sept. 24, 1948

Attention to details of manufacture and assembly; revolutionary design and the provision of highly accurate specially designed jigs, ensure that in each R. & A. Reproducer the cone, voice coil centre and outer pole are inevitably and automatically aligned upon the axis of the speaker. This is why R. & A. Reproducers are free from mechanical defects. Continuous inspection at all stages is a further insurance that no defect can be present in the complete speaker.

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R&A

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SPECIAL PURPOSE VALVES

for R.F. HEATING
COMMUNICATIONS
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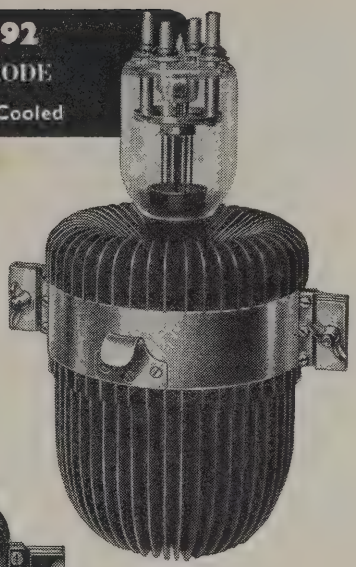
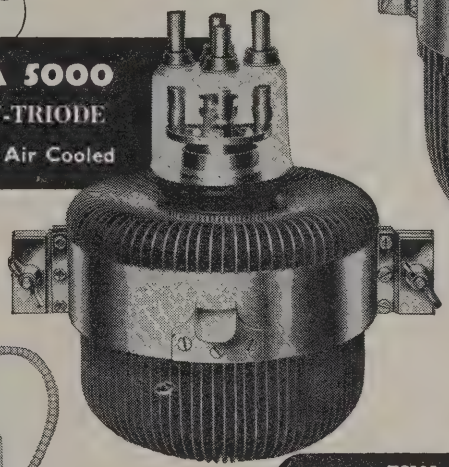
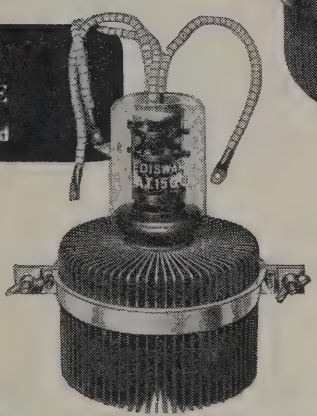


ESA 892
5 KW-TRIODE
Forced Air Cooled

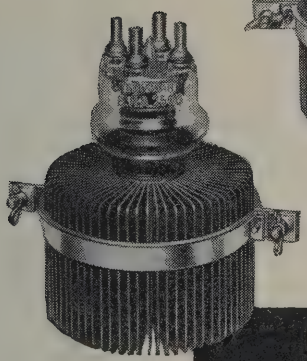


EHA 5000
5 KW-TRIODE
Forced Air Cooled

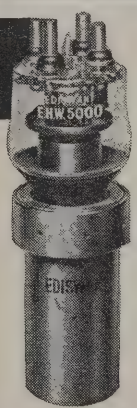


EAT 1500
1.5 KW-TRIODE
Forced Air Cooled

ESW 892
10 KW-TRIODE
Water Cooled



EHW 5000
5 KW-TRIODE
Water Cooled



EHW 3000
3 KW-TRIODE
Water Cooled

EHA 2500
2.5 KW-TRIODE
Forced Air Cooled

Industrial Valve
Folder available
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W.73

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the greatest name in wireless

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PERTRIX

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P5

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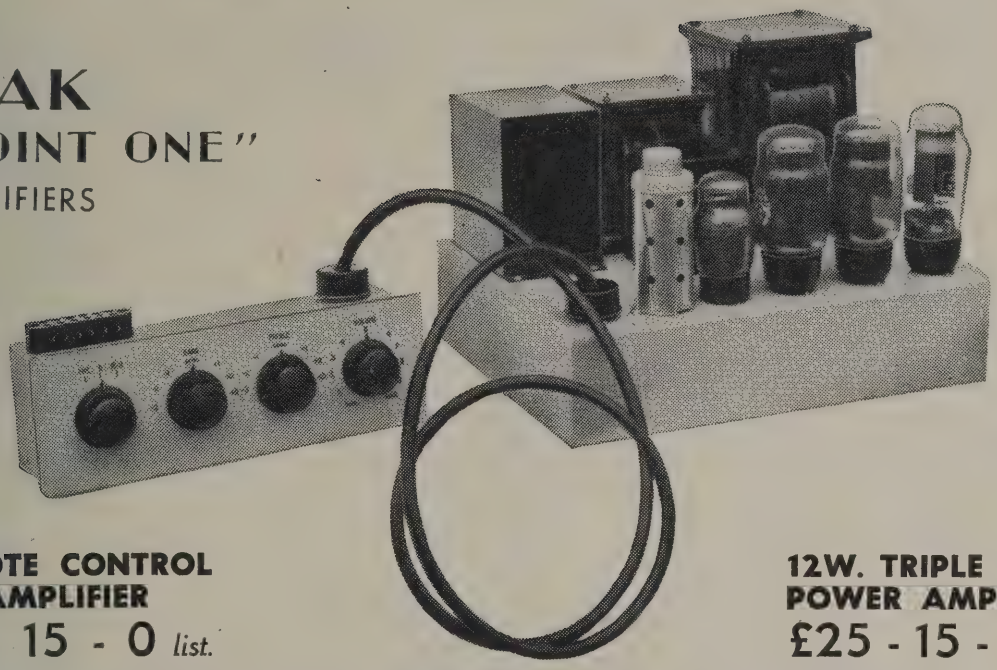

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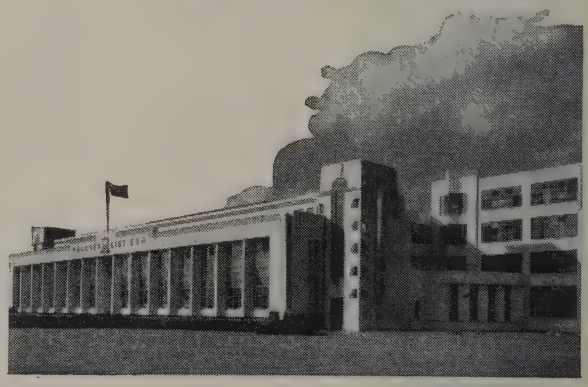

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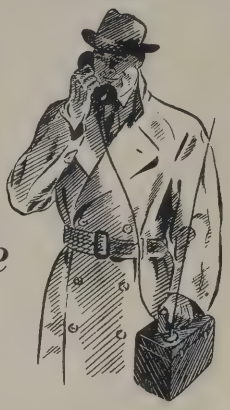

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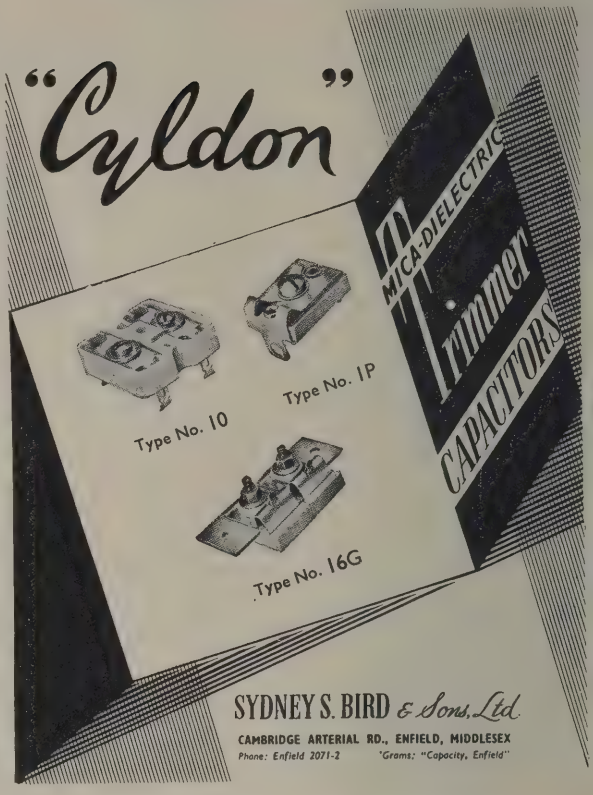

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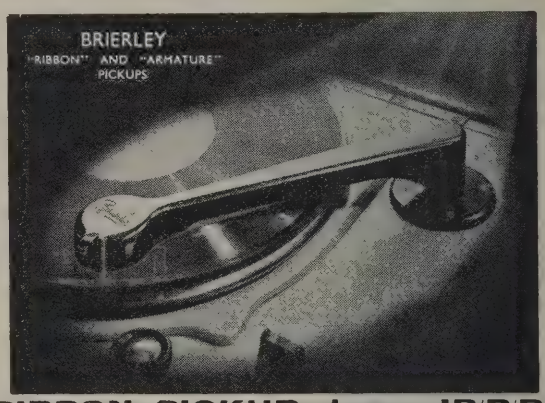

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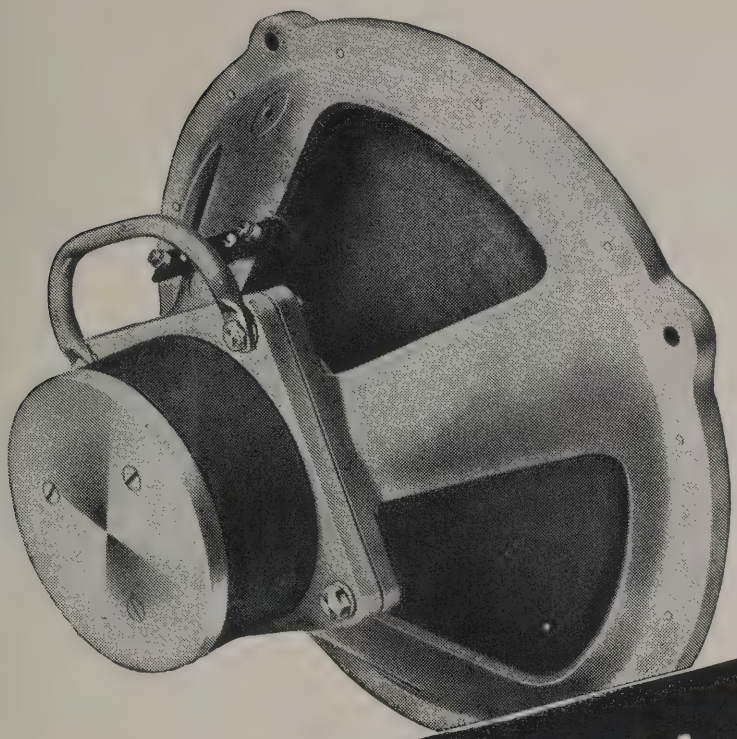

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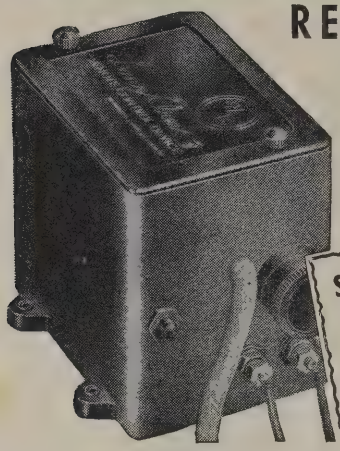

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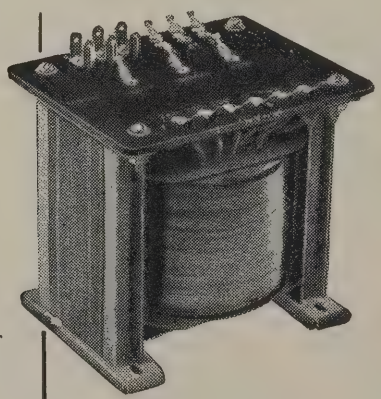

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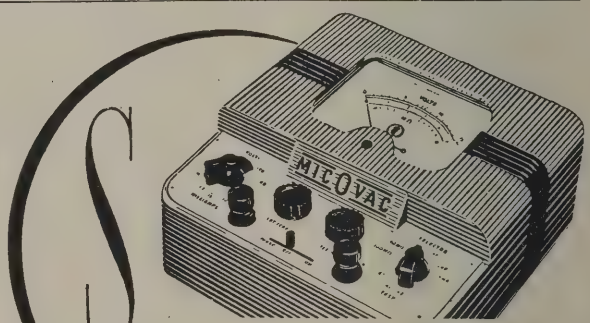

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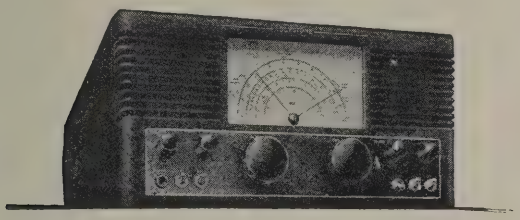

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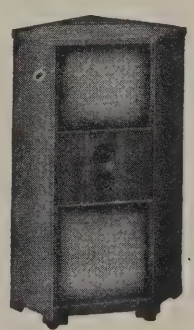

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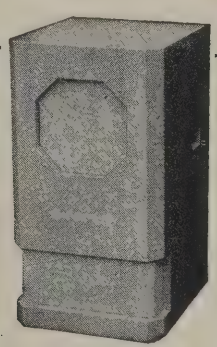

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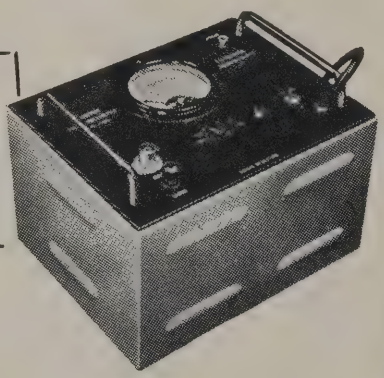

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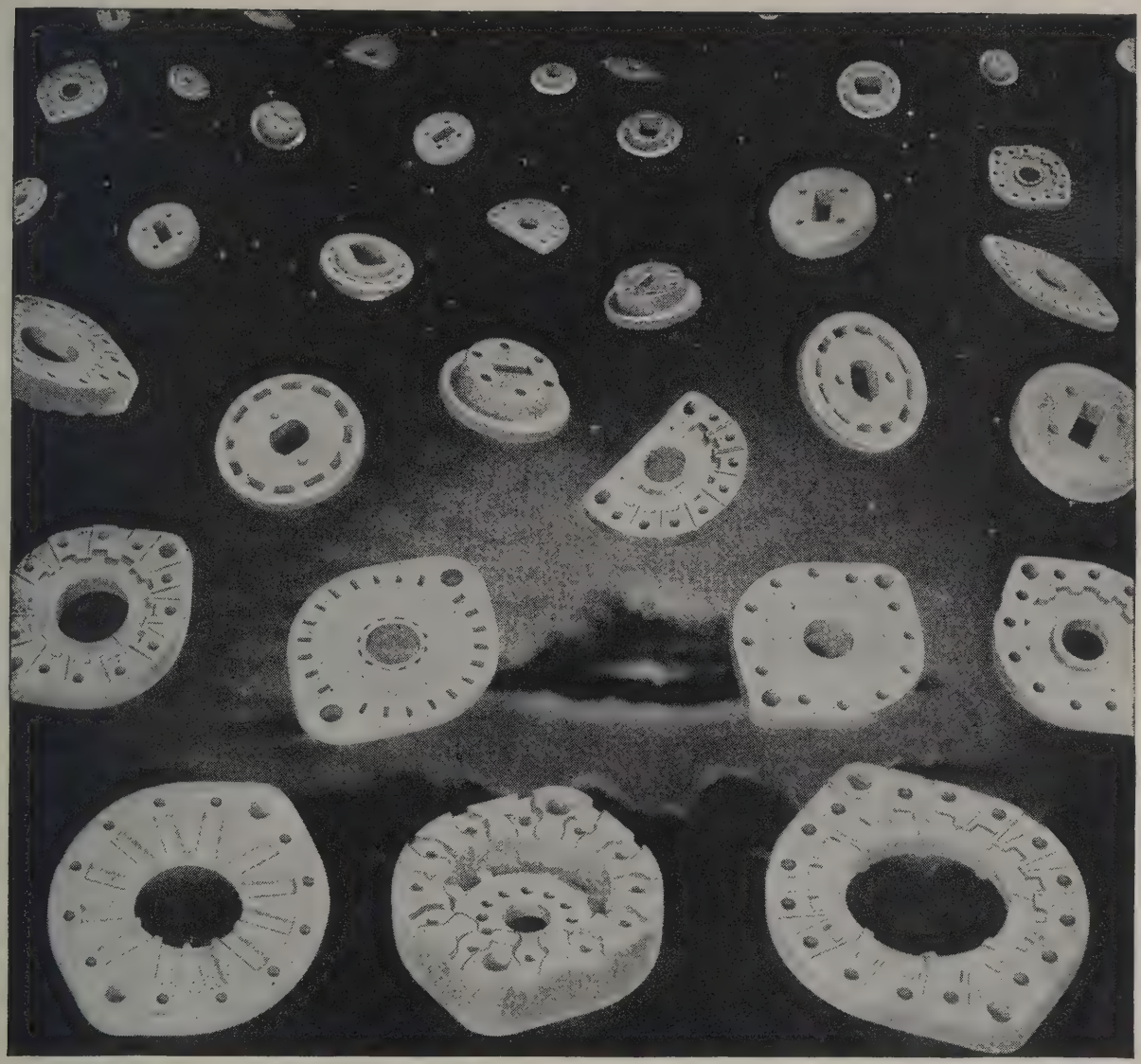

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RESISTORS. (½ watt Carbon). 10, 15, 27, 33, 47, 56, 68, 75, 82, 100, 120, 150, 200, 220, 250, 270, 330, 390, 470, 510, 680, 750, 1,000, 1.2K, 1.5K, 2 K, 2.2K, 2.5K, 2.7K, 3.3K, 3.9K, 4.7K, 5.1K, 5.6K, 6.8K, 7.5K, 10K, 12K, 15K, 18K, 20K, 22K, 25K, 27K, 33K, 39,K, 47K, 51K, 56K, 68K, 75K, 82K, 100K, 120K, 150K, 220K, 250K, 270K, 330K, 390K, 470K, 510K, 560K, 680K, 750K, 820K, 1Meg, 1.2Mg, 1.5Mg, 2.2Mg, 2.5Mg, 3.9 mg, 4.7mg, 10mg, 50mg.

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RESISTORS (3 WATT CARBON). 1.2K, 5.6K, 6.8K, 10K, 20K, 33K, 47K, 50K, 68K, 82K, 120K, 150K 220K, 330K, 470K, 1Meg, 2.2Meg, 6.2Meg. Price **1/6** ea.

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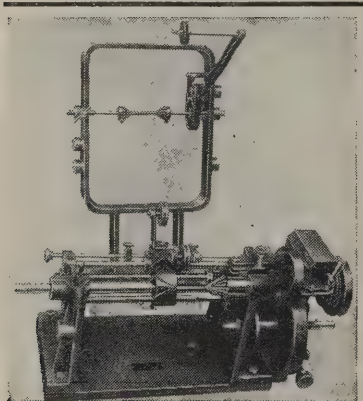

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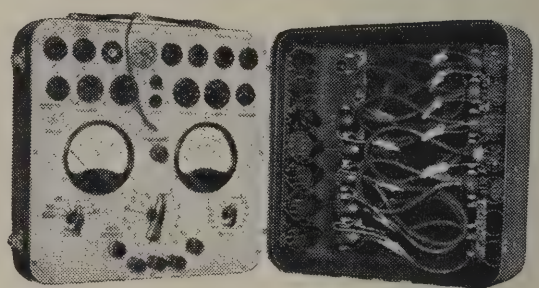

The 'L.S.L." Servicing Method is a combined fault analyser and circuit tester; simultaneously capable of indicating all voltage, current and resistance on each valve electrode without removing the chassis from the cabinet. Readings can be taken whilst the set is under actual operating conditions. The "L.S.L." Analyser is a combination of multi-range instrument and valve tester.

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★ *Saves time and trouble.* ★ *Greatly increases Profit in the Service Department.* ★ *Is portable, can be used on the bench or in the home.* ★ *Is simple to operate.*

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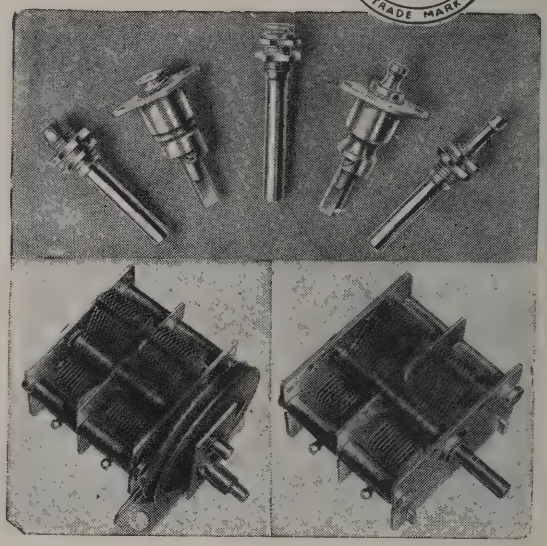

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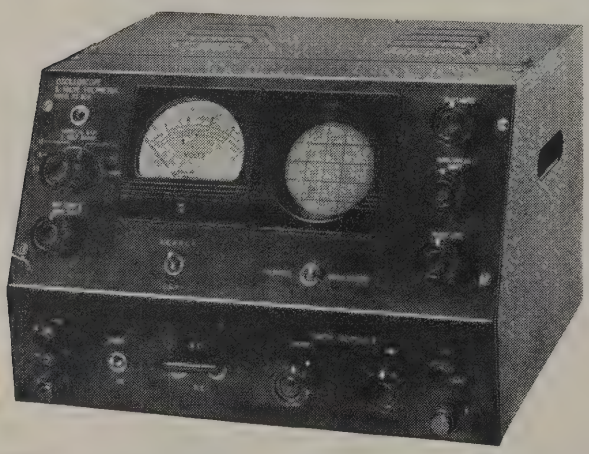

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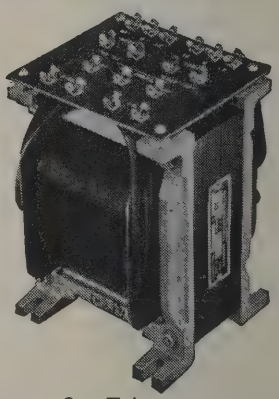

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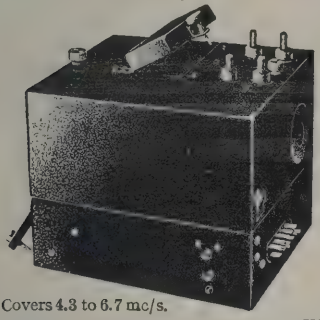
R.A.F. 6-VALVE SUPERHET RECEIVING UNIT No. 25



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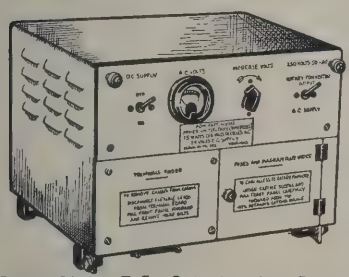

Input 24 v. D.C. Output, 230 v. 50 cycles **£8-10-0**
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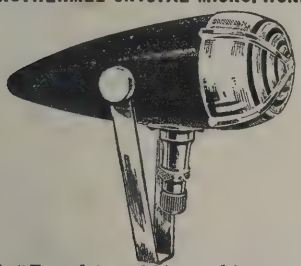
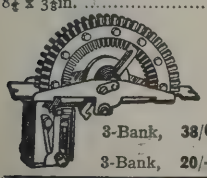


This "Torpedo" model has a driver type of crystal element. A new method of suspension eliminates unwanted peaks and background noise. Sensitivity level is minus 54 D.B. Has high impedance of 80,000 ohms. at 1,000~. Frequency response is fairly flat from 30~ to above 6,000~. Dimensions 8¼ x 3⅛in. **£3-19-6**



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Range 31 mc/s to 90 kc/s, 9 Plug-in coils, 7 valves and rectifier, variable selectivity, B.F.O. stand-by switch, A.V.C. switch, bandspread dial, valve check meter. In heavy black crackle finished steel cabinet with chrome fittings. Complete with 200–250 v. A.C. Power Supply Unit. Carriage and packing 17/6 extra. **£25**

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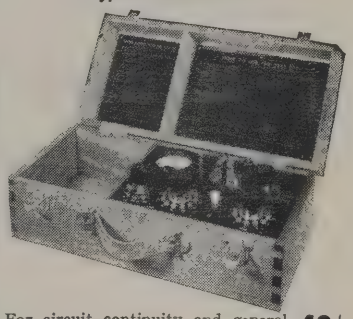

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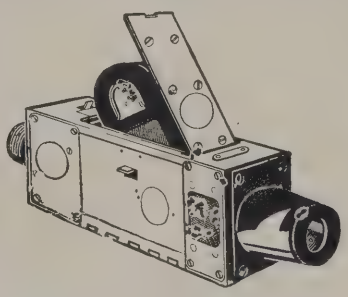

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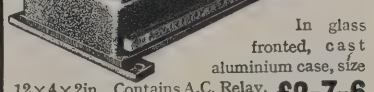

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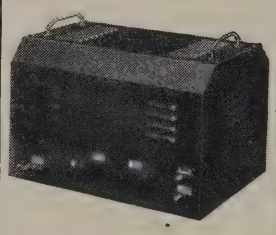

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8½ gns.

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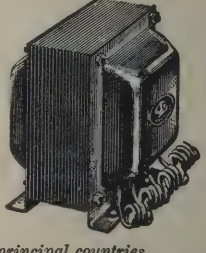

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Trade and export invited. Catalogues on request. Larger types are made. Outputs, chokes, autos. Quality transformers for quality circuits.

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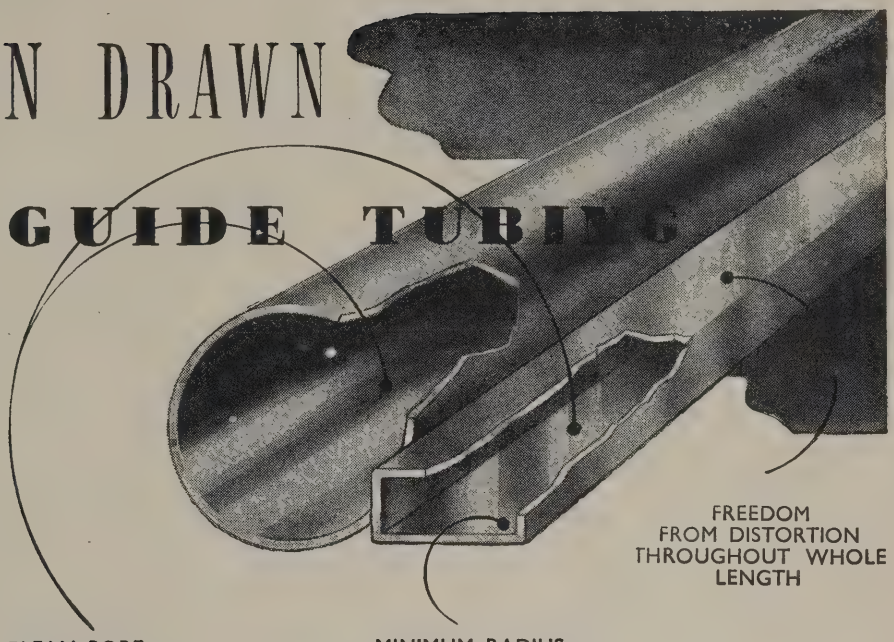
WAVE GUIDE TUBING



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7½% COPPER SILVER	10% COPPER SILVER
SILVER LINED COPPER	SILVER LINED BRASS

Dimensions:

Available in 10 ft. lengths
Rectangular tubes up to 1″×0.5″
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Details of preferred sizes are available on request.

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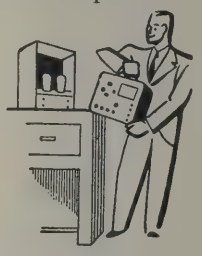

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—M.R. SUPPLIES Ltd.—

for selected material in first-class condition, immediate despatch and assurance of satisfaction. All prices nett.

THERMOSTATIC SWITCHES (ex A.M.) Capacity 1.5 amp. On at 32 deg. F., off at 49 deg. F., therefore right for frost protection. Adjustable. **4/6**, or **45/-** doz.

REMOTE THERMOMETERS (thermo-coupled micro-ammeter type). Scaled −35° to + 55° C. (covering 0/150 deg. F.), 2in. luminous dial. With approx 10ft. wire to temperature rod. Ideal for soil-warming readings and for reading, in situ, outside temperatures. Extremely handy instruments, **15/-**.

ROTARY TRANSFORMERS (Anode Converters). This is the really useful one for mobile radio, etc., for an adequate supply of H.T. from L.T. Input 12 v. D.C., output 250 v. 125 m.a. D.C. Brand new, by Hoover, in original cartons, **21/-**.

CENTRIFUGAL PUMPS. 12/24 v. AC/DC. Immersion type, self-priming, approx. 16in. long. Diameter of tube 2in. Fitted precision motor and expensively made. Remarkable duty—approx. 200 g.p.h. Many uses. Brand new in makers' cartons, **32/6**. Also a new delivery of the well-known **Stuart Pumps**, operation 220/250 v. AC/DC, No. 11 (300 g.p.h.), **27** (des. 2/6). No. 12 (600 g.p.h.), **£8/10/-** (des. 2/6).

LARGE CENTRIFUGAL BLOWERS, rated for 100 v. D.C. (suitable for non-continuous running on A.C.) Diameter of impeller housing 11in., overall length 11in. Outlet 2in. Motor is 3/8th H.P. Very powerful blast. Mounted on base 11in. by 10in., fitted 2-pole ironclad switch, new **£3/10/-** (des. 5/-).

"FUZIT" WIRE JOINTERS, by S.T.C. Electrically weld all wires (copper and resistance), 30 to 50 S.w.g. Operation 200/250 v. A.C. With portable transformer (sec. 45 v. 5 amps. continuous), carbon-electrode Hand-Tool etc., ready for use, brand new £6/6- model for **45/-** (des. 2/-). The excellent transformer alone is worth more.

CLOSE-RANGE-AUTO-TRANSFORMERS, for adjustment of mains volt-drop. Covers range of 200/250 volts in 10 v. taps, loading 500 watts, **27/6** (des. 1/6).

SYNCHRONOUS ELECTRIC CLOCK MOVEMENTS, 200/250 v. 50 c. Spindles for hours, mins., and secs., centre bush mount. Silent and fully reliable. With plastic dust-cover 3¾in. dia., 1¾in. front to back, and flex lead, **37/6**. Set of three Hands to fit, in good style, to suit 5/6in. dial, **2/-**.

HAND-BEARING COMPASSES, type 06A. Prismatic, alcohol floated. Dia. 3¾in. Torch illuminated (battery not supplied). Overall length 8¾in. In wooden transit case, in new condition, **55/-** (des. 1/6).

EXTRACTOR FANS (can be used as blowers). Tank model, brand new. 12/24 v. AC/DC. Overall 7in. Diameter of impeller, 5¼in. Ideal for extraction or cooling in confined spaces—excellent motor, **15/6** (des. 1/6).

HIGH-SPEED MOTORS, 12/24 v. AC/DC. Full 1/6th H.P. 6,400 r.p.m. Length of body 5in. New, slightly soiled, perfect electrically, **25/-** (des. 1/6).

GOVERNED MOTORS, 24 v. D.C. or 50 v. A.C. Centrifugal device controls speed at 2,520 r.p.m. (can be adjusted). Overall length 7¼in. Expensively made for Teleprinter. Brand new, **27/6** (des. 1/6).

MILLIAMMETERS, 2in. square, panel mount, 0/1 m.a. new, boxed, **9/6**.

CAMBRIDGE THERMO-COUPLES for instruments. Rated 5 m.a. (max. 10 m.a.) With standard 4-pin valve cap. Boxed, with test-data label, **7/6**.

STAGE LIGHTING DIMMERS. Controlling stated load from full-bright to blackout at 220/240 v. Sliding type: 100-watt, **32/6**. 200-watt, **37/6**. 500-watt, **59/6** (des. 2/-). Screw-motion type with Handwheel: 500-watt **£3/18/6**, 1,000-watt **£7/2/6**, 1,500-watt **£8/12/6**, 2,500-watt **£9/15/-** (des. 4/6).

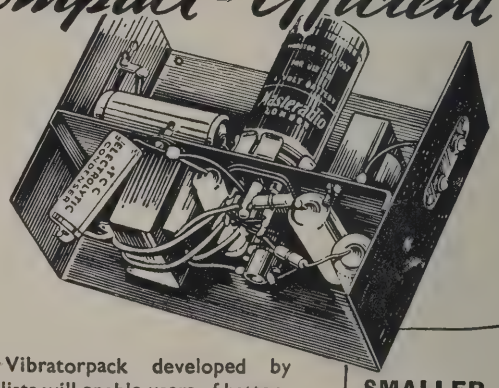
SIGNAL GENERATORS by Marconi, R.C.A. and Cossor, etc., as fully described in our December advertisement. A few of each model available at time of going to press.

ANY RATING of Mains Transformers and Variable Resistances supplied to order. Please send enquiries. First-class material only.

M. R. SUPPLIES Ltd., 6C, New Oxford Street, London, W.C.1

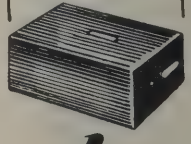
Telephone; MUSeum 2958

Compact-Efficient



This Vibratorpack developed by Specialists will enable users of battery sets to operate from a 6-volt car accumulator, thus eliminating expensive H.T. battery replacements. Careful design has eliminated all interference. Consumption is less than ¾ amp.

SMALLER *than a H.T. Battery.* *Size: 7 × 5½ × 3*



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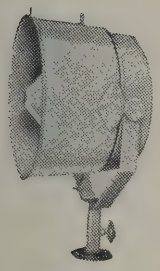
VIBRATORPACK

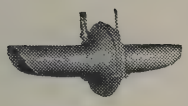
MASTERADIO LTD., Sales Dept., 319/321, Euston Road, London, NW.1

The NEW "STANELECT" LOUDSPEAKERS ARE — HERE!

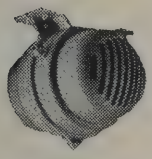


Giant 6 unit Hailer type "S"

Standard Marine Hailer type "C"



Controlled Beam Duo-Directional Loudspeakers



Duo-Directional Loudspeaker for Ceiling Mounting

Wall Mounting Loudspeaker

Speakers for every purpose, from Watertight Marine Loud-hailers for Ocean Liners, to Paging Units suitable also for "Music while you Work" in Factories.

Representing a remarkable advance in constructive and aesthetic features, the new Stanelect speakers are encased in durable Alloy Die Castings.

In this range there are units which are ideal for any installation you may have in mind, even so, if you are a bulk user, Standards can design and make speakers especially for your needs.

Standard Electric LONDON

STANDARD ELECTRICAL ENGINEERING CO.,
MAKERS OF PRECISION COMMUNICATION APPARATUS
STANELECT HOUSE 16, HENEAGE LANE, LONDON, E.C.3.
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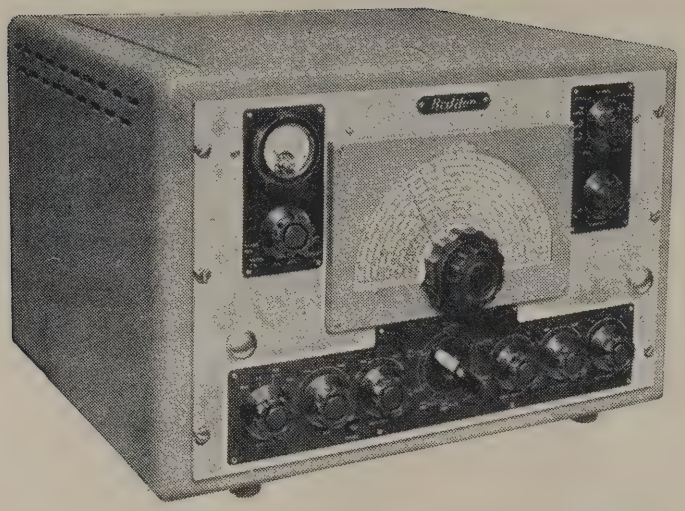


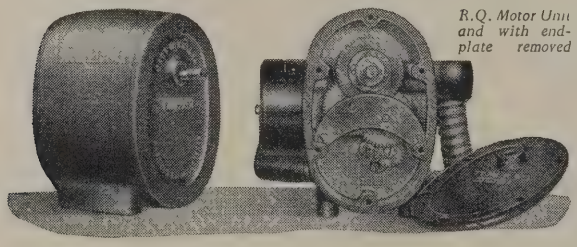
Sets a New High Standard

R.50
COMMUNICATIONS RECEIVER

This high-grade communications receiver incorporates the most highly developed techniques in modern receiver design. Five degrees of selectivity, including a crystal gate and crystal filter are provided, and the sensitivity is such that an input of between 1—5 microvolts gives a signal/noise ratio of at least 10 dB over the entire frequency range of 13.5 to 26 kc/s and 95 kc s to 32 Mc/s. Separate power units for A.C. or D.C. operations are available.

COMMUNICATIONS
Rediffon
Radio

REDIFFUSION LIMITED, BROOMHILL ROAD, WANDSWORTH, S.W.18
DESIGNERS & MANUFACTURERS OF RADIO COMMUNICATION & INDUSTRIAL ELECTRONIC EQUIPMENT Phone PUTney 5691
RC 201



R.Q. Motor Unit and with end-plate removed

SMALL GEARED MOTOR UNITS

The Drayton "R.Q." is a 25-watt motor unit geared to a final shaft, to which may be fitted eccentrics, arms or cranks, gears, links or pulleys for actuating valves or dampers, movements, switchgear or other devices.

Supplied continuous running or reversing, with or without self-switching, for 100/110 or 200/250 volts A.C

Both types are fitted with an auxiliary two-way switch actuated by movement of the final shaft, for operating auxiliary gear such as fan motors, pumps, interlocking devices, etc.

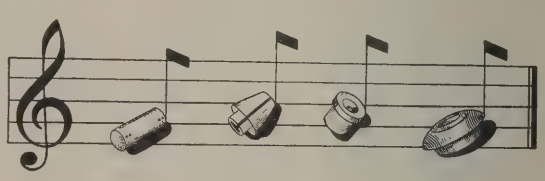
Final Shaft Speeds:
600 r.p.m./27 min. per rev.
Torque: **60 in. lbs.** ***Consumption:*** **25 W.**

for

Operating Valves, Dampers or Rheostats, Cinema Projectors, Rotating Screens, Illuminated Signs, Small Working Models, Geneva Movements for Drum-type Switches, Rocking Baths, Work Movement, Soldering and Welding Fixtures, Continuous Turning, Feed of Light Strip under Process.

DRAYTON 'R.Q.'

Send for List No. N302-1
DRAYTON REGULATOR & INSTRUMENT CO., LTD., WEST DRAYTON, MIDDLESEX.
RQ7



make a note of Thompson's wood turnings

If you have a special fitting in mind which you think could be made better, or more economically or quicker in wood ask Thompson's advice on it—woodturnings for 1001 trades.

Any turning in any wood to engineers' precision standards from blueprints, drawings or samples.

W. & J. R. THOMPSON
(WOODTURNERS) LIMITED. EST. 1862
CROSS HILLS, KEIGHLEY, YORKSHIRE.
Phone: Crosshills 2312 (two lines) Grams: Turnwood, Crosshills.

PREMIER RADIO COMPANY

MORRIS & CO. (RADIO) LTD.

NEW BRANCHES AT

207, EDGWARE RD., W.2 Phone: AMBassador 4033

AND AT **152-153, FLEET STREET, E.C.4** Phone: CENtral 2833

All **POST ORDERS** to 167, LOWER CLAPTON ROAD, LONDON, E.5. *'Phone AMHerst 4723.*

Terms o Business: Cash with order or C.O.D. over £1. Send 2d. Stamp for list.

C.R. TUBES

3-inch EMISCOPE, 4/1 (Marconi) as used in W.W. Scope (December '48), **17/6.** Complete kit of 8 valves, **£3/7/6.** All other parts available.

VC. R97. New, with socket, **35/-. 5 CP1,** with socket, Guaranteed perfect, **20/-.**

MULLARD M.W. 18-2. New, with base, **79/6.**

V.C.R.138, with socket, **19/6.**

RADAR OSCILLOSCOPE. APN-4 contains 7-6H6, 1-6SJ7, 18-6SN7, 1-5CP1 and 100 kc. crystal, **£3/19/6.** Carriage and packing 10/-. Unit less valves, with 5CP1, **25/-**; 100 k/c crystal only, **12/6.**

RECEIVER AND POWER SUPPLY for above unit contains 1-6SN7, 1-6SL7, 1-6H6, 4-6SK7. 1-VR10-350, 1-6SJ7, 2-2×2, 1-5U4G, 3-6B4, 1-6SA7, 400/1200 cycle input, **£3 7/6.** Carriage and packing 7/6.

RECEIVER TYPE 184. Radar Unit containing 14 valves: 1 CU67, 4 VR91, 7 VR65, 1 VU111, 1 VR92. Unit contains a 45 mc/s I.F. Strip suitable for use as a Vision Receiver. There is ample space for building Power Packs or Time Bases. Also included are 5 Potentiometers. .01 mfd. 2,500-volt Condenser, 2 Relays, 3 Neon Lamps, a quantity of Resistors, Condensers and Co-Axial Sockets. **£2/5/-.**

SPECIAL OFFER OF ELECTROLYTIC CONDENSERS.

16+16 mf.	500 v.	working, Cardboard	4/11
8+8 mf.	500 v.	„ „	4/11
32+32 mf.	350 v.	„ Ali. Cans	5/11
32 mf.	350 v.	„ „	2/6
16 mf.	350 v.	„ „	2/6
16 mf.	450 v.	„ Cardboard	3/9
8 mf.	450 v.	„ „	3/-
4 mf.	500 v.	„ „	2/-
16+8 mfd.	450 v.	Ali. Cans	4/11

GOVERNMENT SURPLUS MAINS TRANSFORMERS. All are for use on 230 volt 50 cycle Mains.

Type		
33	38 v. 2 a. Tapped at 32, 34, 36 v.	15/-
42	500-0-500 v. 170 mA 4 v. 4 a.	35/-
44	10 v. 5a., 10 v. 5 a., 10 v. 5 a.	35/-
50	12 v. 70 a. An ideal Transformer for soil heating or welding	60/-
51	350-0-350 v. 60 mA, 6.3 v. 1 a., 6.3 v. 2-5 a...	12/6
52	250-0-250 v. 65 mAm 4 v. 1.5 a., 6.3 v. 2 a...	12/6

E.H.T. TRANSFORMERS. For 200-230 v. 50 c. input Half Wave. For use with Valve or Metal Rectifier. Used in a Voltage Doubling Circuit, these will give slightly over double the half wave output. We can supply suitable rectifiers.

E.H.T.1.	Output 800 v.	17/6
E.H.T.2.	Output 1,000 v. and 2-0-2 v. 2 a.	25/-
E.H.T.3.	Output 2,000 v. and 2-0-2 v. 2 a.	35/-

TANK AERIALS. Seven 2ft. lengths of steel tube which fit into each other, making a very efficient aerial. **3/6** each

Rubber Bases to fit ..... **2/6** each

PREMIER COIL PACK 4-BAND. Consists of a fully wired and calibrated Coil Pack of the latest type. 5-position switch includes a gram. position.

Wavebands covered 13.6-52 metres (22-5.8 mc/s), 51-200 metres (5.9-1.5 mc/s), 200-550 metres and 900-2,100 metres. Air Dielectric Trimmers on all Short Wave Coils Unit consists of 3 screened sections AERIAL, R.F. and Oscillator.

Dimensions of Pack, 6in.×4½in.×2½in.

Also included pair I.F. Transformers with permeability tuned Litz windings of high "Q" 3-gang condenser drive spindle, drive wheel.

Price, with circuit diagram **85/-**

or complete with coloured glass dial, backplate, pointer, dial light brackets and drilled 7-valve chassis, with blue prints, **£5/10/-.**

MOVING COIL EARPIECES

Comprise a 1¾in. Moving Coil Loudspeaker fitted with noise excluding rubber caps. Make excellent Mikes. Phones or Speakers, **2/-** each, **18/-** doz.

PLESSEY AUTO CHANGER with magnetic pick-up. A.C. 200/250 v. 8-records mixed, **£18/6/8.**

GARRARD ELECTRIC GRAMOPHONE UNIT with magnetic pick-up, A.C. 100/250 v. **£5/19/5.**

COLLARO AUTO CHANGERS with magnetic pick-up, A.C. 100/250 v. **£22 4/4.**

COLLARO ELECTRIC GRAMOPHONE UNIT with magnetic pick-up and auto stop. A.C. 100/250 v. **£9/13/6.** With crystal pick-up, **£11/2/2.**

COLLARO ELECTRIC GRAMOPHONE MOTOR with 12in. turntable. A.C. 100 250 v. **£5/18/4.**

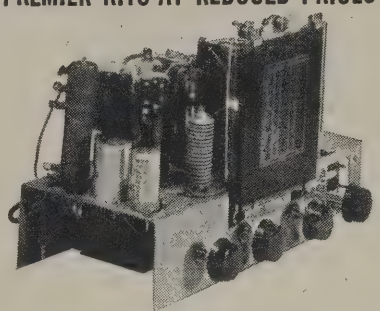
CONRAD ELECTRIC GRAMOPHONE MOTOR. 9in. turntable. 200/250 v. A.C **57/6.**

All above motors include Purchase Tax.

OSCILLOGRAPH POWER UNITS. Input 230 volts. Consists of Kit of Parts incorporating Mains Transformer, metal rectifier, voltage doubling condensers.

Type		
408	Output 800 v.	25/-
409	Output 1,800 v.	30/-
25	Output 2,500 v. at 3 mA and 4 v. 2 a. C.T. For use with 2 or 4 v. C.R. Tubes	49/6
55	Output 5,500 v. at 3 mA and 4 v. 2 a. C.T. For use with 2 or 4 v C.R Tubes	81/-

PREMIER KITS AT REDUCED PRICES



ALL-WAVE SUPERHET KIT. A Kit of Parts to build a 6-valve (plus rectifier) receiver, covering 16-50 metres. Medium- and Long-wave bands. Valve line-up, 6K8, 6K7, 6Q7, 6J7, two 25A6 in push-pull. Metal Rectifiers are incorporated for H.T. supply. Output impedance is for 3 and 15 ohms. The latest Wearite Coil Pack incorporating Iron Dust Coils is used making construction and alignment extremely simple. A pick-up position on the wave-change switch and pick-up terminals is provided. A complete kit, including valves, but without speaker or cabinet. Chassis size, 14in.×6in. Overall height, 9in. Price **£10/16/6,** including Purchase Tax. Wired and tested, **£12/10/-.**

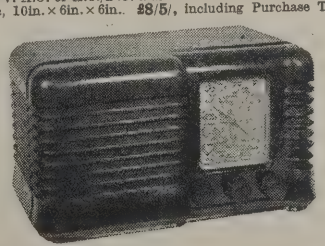
Suitable loudspeakers are the GOODMANS 10in. 6-watt P.M. at **47/6,** or for superlative reproduction, the Goodman's 12in. P.M. at **£6/15/-.**

NEW 2-VALVE ALL WAVE KIT. 16 to 2,000 metres. Switched Coil Pack ready wired and tested. 2 Mazda HL23 Valves, Phones, H.T. and L.T. Batteries, Condensers, resistors, diagrams and steel case, all ready to assemble, **£3/10/-,** including Purchase Tax.

ALL WAVE RECEIVER KIT. 7-Valve (plus Metal Rectifier for H.T. Supply) Superhet; for AC/DC Mains 200/250 volts, 40/60 cycles. Four wavebands 13.6-52 metres (22-5.8 mc/s), 51-200 metres (5.9-1.5 mc/s) 200-550 metres and 900-2100 metres. The five position Switch includes a Pick-up Position, and Pick-up Terminals are provided. Valve line-up 6K7 (R.F.), 6K8 (Frequency Changer), 6K7 (I.F.), 6Q7 (2nd Det. A.V.C. and 1st L.F. Amplifier), 6J7 (Phase Inverter) 2×25A6 (Push Pull Output). Specially designed Output Transformer to match the 25A6's to Speaker of 3 or 15 ohms impedance. Negative feedback is applied over three stages, giving a very high fidelity output. The Coil Pack which is tested and calibrated is of the most modern type. Substantial smoothing gives an exceptionally low hum level. Large illuminated Glass Dial in colour.

The Complete Kit of Parts including Valves and Complete Instructions, **£13/8/10,** inc. tax. Completely wired and tested, **£15.** Recommended Loudspeaker. Rola Super G.12, **85/-.**

NEW 1948 MIDGET SUPERHET RADIO KIT, with Illuminated Glass Dial. All parts, including Valves M/C Speaker and Instructions, 4 valves plus Meta. Rectifier. 16-50 metres and 200-557 metres. 200 to 250 v. A.C. or A.C./D.C. mains. State which is required. Size, 10in.×6in.×6in.. **£8/5/,** including Purchase Tax.



MIDGET RADIO CABINETS in Brown Bakelite. Can be supplied for the above Midget Kits at **25/-,** including P.T.

NEW MIDGET T.R.F. RECEIVER. Special offer of completely built and tested T.R.F. Receivers in bakelite cases. Medium and Long Wavebands. Size 12in.×9in.×6in. As illustration. Two models are available an A.C. and an A.C./D.C. Both for 200-250 v. mains. These are offered at the pre-war price of **£7/19/6.** Including Purchase Tax.

METERS

Full Scale Deflection	*Scale Marking*	*External Dimensions*	*Movement*	*Price*
1 mA	0—100	3½"	M/C	15/11
1 mA	0—1	2½"×2½"	M/C	7/6
5 mA	0—5	2½"	M/C	5/-
25 mA	0—25	2"	M/I	12/6
30 mA	0—30	3½"	M/C	10/6
50 mA	0—50	2"	M/I	12/6
50 mA	0—50	2¼"×2¼"	M/C	8/6
100 mA	0—100	2"	M/I	12/6
150 mA	0—150	2½"	M/C	6/-
250 mA	0—250	3¼"	M/C	10/-
1 amp.	0—1	2"	M/I	12/6
2.5 amp.	0—2.5	2½"	Thermo.	5/-
8 amp.	0—8	2¼"×2¼"	M/I	12/6
20 amp.	0—20	2½"	M/C	7/6
25 amp.	0—25	3¼"	M/I	2/11
40 amp.	0—40	2½"	M/C	7/6
15 v.	0—15	3½"	M/I	7/6
20 v.	0—20	2½"×2½"	M/C	5/9
40 v.	0—40	2¼"×2¼"	M/C	5/9
2000 v.	0—2000	3¼"	Elect.	25/-
5000 v.	0—5	4½"	Elect.	50/-
500 u.a.	0—500	2½"	M/C	7/6
500 u.a.	0—500	3¼"	M/C	19/6

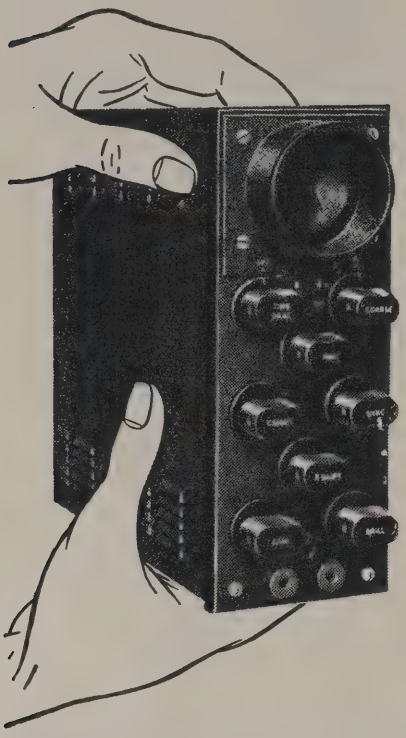
PREMIER MAINS TRANSFORMERS

All primaries are tapped for 200-230-250 v. mains 40-100 cycles. All primaries are screened. All LTS are centre-tapped.

List No.	*Output*		*Price*
SP. 250A	250-0-250 v.	60 mA, 6.3 v. 2-3a., 5 v. 2 a.	25/-
SP. 300A	300-0-300 v.	60 mA, 6.3 v. 2-3 a., 5 v. 2 a.	25/-
SP. 301A	300-0-300 v.	120 mA, 5 v. 2-3 a., 6.3 v. 3-4 a. ...	28/-
SP. 350A	350-0-350 v.	100 mA, 5 v. 2-3 a., 6.3 v. 2-3 a. ...	29/-
SP. 352	350-0-350 v.	150 mA, 5 v. 2-3 a., 6.3 v. 2-3 a., 6.3 v. 2-3 a. ...	36/-
SP. 375A	375-0-375 v.	250 mA, 6.3 v. 2-3 a., 6.3 v. 3-5 a., 5 v. 2-3 a. ...	46/-
SP. 375B	375-0-375 v.	250 mA, 4 v. 2-3 a., 4 v. 2.3 a., 4 v. 3-6 a. ...	46/-
SP. 425A	425-0-425 v.	200 mA, 6.3 v. 2-3 a., 6.3 v. 3-5 a., 5 v. 2-3 a. ...	47/-
SP. 425B	425-0-425 v.	200 mA, 4 v. 2-3 a., 4 v. 2.3 a., 4 v. 3-6 a., 4 v. 2-3 a. ...	47/-
SP. 501A	500-0-500 v.	150 mA, 5 v. 2-3 a., 6.3 v. 2-3 a., 6.3 v. 2-3 a. ...	50/-
SP. 503	500-0-500 v.	250 mA, 5 v. 2-3 a., 6.3 v. 2-3 a., 6.3 v. 3-5 a. ...	65/-

LOUDSPEAKERS BY FAMOUS MAKER

5in. P.M.	2-3 ohms	.....	10/-
6in. „	2-3 „	.....	16/6
8in. „	2-3 „	.....	17/6
10in. „	2-3 „	.....	23/6
12in. „	15 „	.....	85/-



MASTERPIECE IN MINIATURE

WIDTH	$2\frac{1}{2}$"
HEIGHT	$6\frac{3}{4}$"
DEPTH	$9\frac{1}{4}$"
C.R.T. DIAMETER	$1\frac{1}{2}$"
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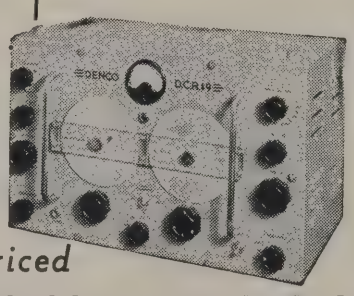

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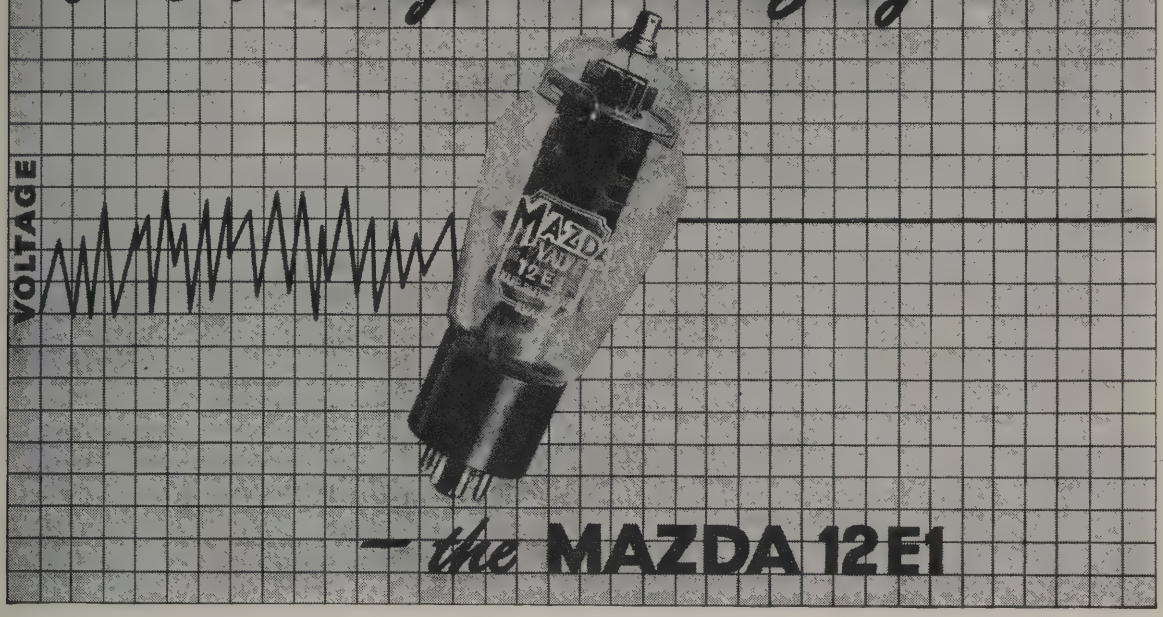

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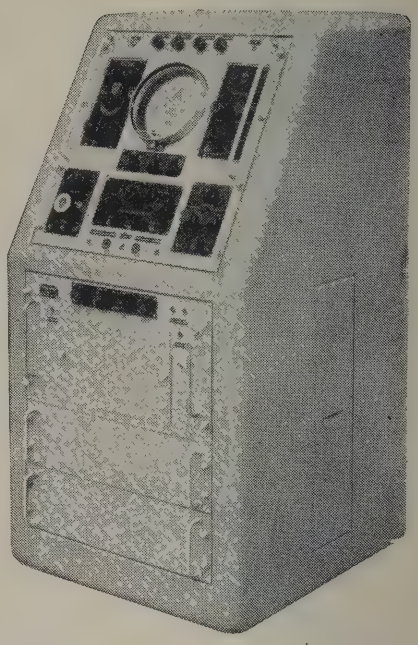

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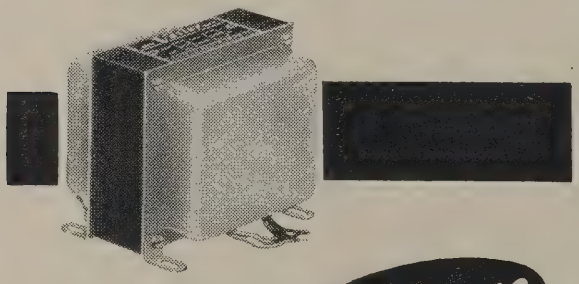

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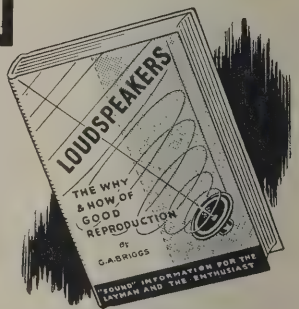

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K401	16	450	A	5″	1⅜″	8 0
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K403	24	450	C	3½	1″	8 9
K404	32	450	C	3½	1⅜″	10 0
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K406	8+16	450	A+C	5″	1⅜″	11 0
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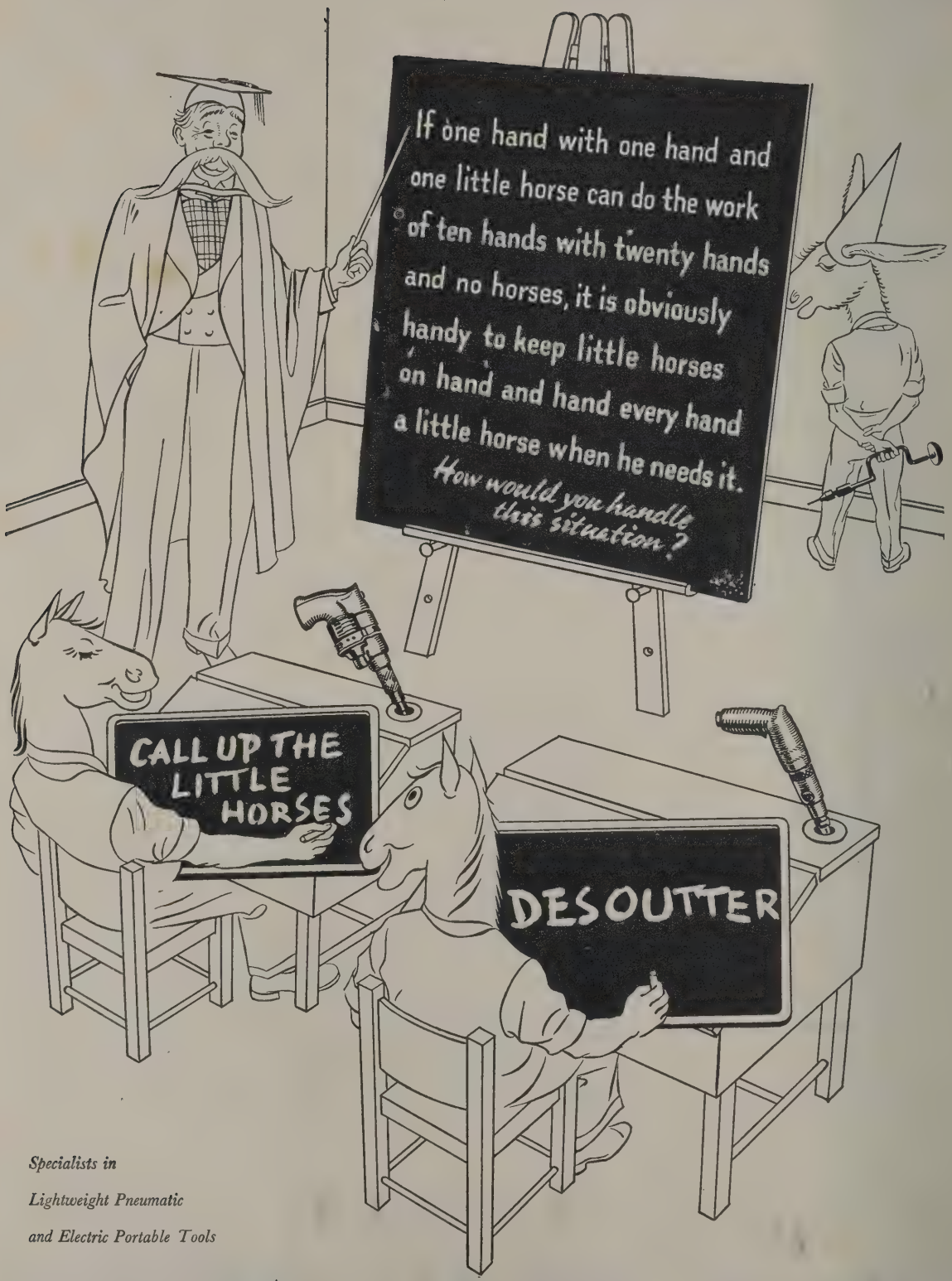
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C.R.C. 104

Wireless World

RADIO AND ELECTRONICS

38th YEAR OF PUBLICATION

JANUARY 1949

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In This Issue

OUR COVER : Cinema Television Projector (See Page 10)

EDITORIAL COMMENT 1
LOW-IMPEDANCE VARIABLE-VOLTAGE TAPPINGS. By M. G. Scroggie 2
"Q" METERS. By H. G. M. Spratt 7
DISTORTION : DOES IT MATTER ? 11
AMATEUR RADIO SHOW 13
BOOK REVIEWS 15
COMPACT MARINE RADAR 16
TELEVISION DISTRIBUTION. By P. Adorian 18
VERSATILE POWER SUPPLY. By K. F. Butcher 21
ELECTRONIC CIRCUITRY. By J. McG. Sowerby 23
WORLD OF WIRELESS 25
ADMITTANCE. By "Cathode Ray" 29
SHORT-WAVE CONDITIONS 32
UNBIASED. By "Free Grid" 34
LETTERS TO THE EDITOR 35
RANDOM RADIATIONS. By "Diallist" 38
RECENT INVENTIONS 40

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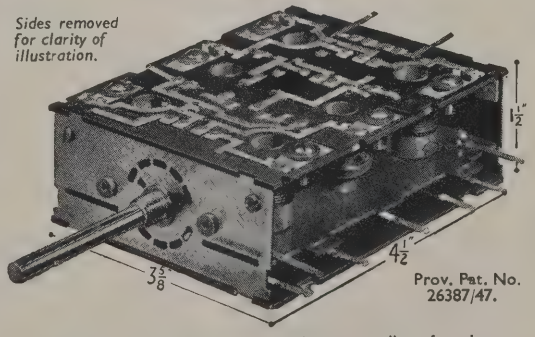

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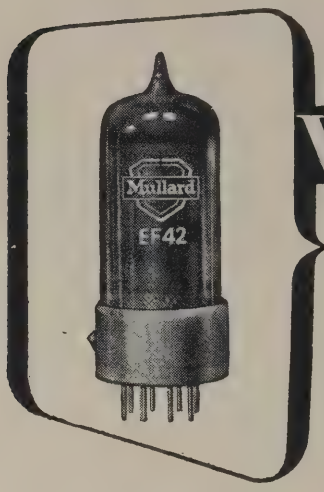


Valves and their applications

THE EF42 IN THE OUTPUT STAGE OF A WIDE-BAND OSCILLOGRAPH AMPLIFIER

In the design of a high-gain amplifier for a C.R. oscillograph, it is usually necessary to consider the output stages first, as the major frequency limitations usually occur at this point.

A C.R. tube presents a largely capacitative load to the preceding stage which must therefore have a low anode load resistance, while the voltage swing required for full deflection of the beam entails a high maximum current.

When an ECR35 C.R. tube operating at 1.2 kV is used, a total signal of 180V (peak to peak) must be provided on the most sensitive plates (allowing, say, 25% over-deflection) and if this is derived from two EF42s in push-pull, each must give 90V.

With a 250V H.T. line, the EF42 will give this signal swing across a 5KΩ anode load resistance provided that a little non-linearity can be tolerated at the lower limit of current. This is quite permissible as over-deflection has been allowed for. The bias resistor necessary for this condition is 180Ω.

This amplifier-C.R. tube combination has a frequency response falling by rather more than 3db at 1 Mc/s., but this may be improved by compensation. One of the most convenient methods of doing this is to arrange that negative feedback shall appear in the amplifier at low frequencies, while at high frequencies the full amplification shall be used. This can be carried out in a variety of ways, but the most convenient and economical in components is that in which the existing cathode resistor is partially by-passed by a small capacitor.

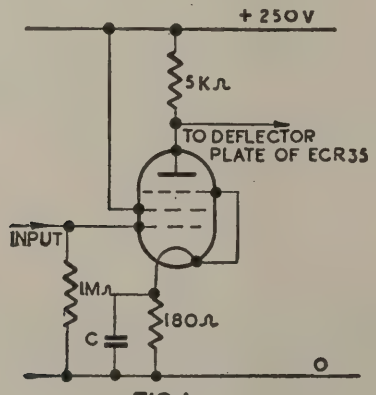
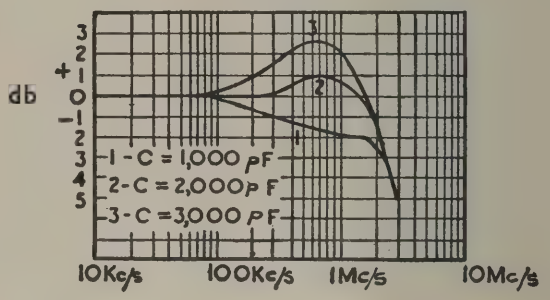


FIG:1

FIG:2



The circuit of the amplifier then becomes that shown in Fig. 1, while Fig. 2 indicates the frequency responses that can be obtained when three different values of cathode by-pass capacitor (C) are used. It must be remarked, however, that at high frequencies the full sweep available at low frequencies will not be obtained from the valve owing to the current swing limitation.

The transient response of the amplifier — usually a more important feature where oscillographs are concerned — is such that a square wave with a rise-time of 0.2μs is reproduced with an "overshoot" of 0%, 10%, or 20% when the cathode capacitor is 1,000pF, 2,000pF or 3,000pF respectively.

On this basis, a capacitor of 1,500pF would probably be satisfactory in most cases, but if the preceding amplifier stages were found to limit the response severely, up to 2,000pF could be used, as such rapidly rising transients would never reach the output stages. The amplifier gives a voltage gain of 15 times when used under these conditions.

Mullard

Reprints of this report from the Mullard Laboratories, together with complete circuit diagram of a push-pull amplifier and circuit notes, can be obtained from the address below.

MULLARD ELECTRONIC PRODUCTS LTD., TECHNICAL PUBLICATIONS DEPARTMENT, CENTURY HOUSE, SHAFTESBURY AVE., W.C.2

(MVM81)

VOL. LV. NO. 1

Wireless World

RADIO AND ELECTRONICS

JANUARY 1949

Comments of the Month

POPULARIZING TELEVISION

CONSIDERING that there is only one transmitter at present working in this country, the spread of television may be regarded as satisfactory. But the time will probably come when the potential output of receivers is greater than public willingness to absorb them; this state of affairs will certainly come about all too soon unless energetic steps are taken to dispel doubts, which still seem widespread in the lay mind, as to the adequacy of picture quality. The desirable end can best be achieved by well-organized public demonstrations, and we are glad to see that the Radio Industry Council has already made a start in this direction.

So far, most members of the public have gained their first impressions of television from demonstrations in retail shops. Without belittling the efforts of individual dealers, many of whom have shown great resource and enterprise, it is true to say that conditions in shops are inherently unfavourable, or even unfair, as they are worse than those obtaining in the average home. The interference level prevailing in a busy thoroughfare is higher than in most residential districts. Moreover, the average person naturally hesitates to visit a shop unless he has almost made up his mind to buy a television set.

Co-operation between industrial organizations and public bodies seems to be needed to ensure that in every large centre of population where a service is available the interested citizen can see demonstrations that fill all the requirements. We believe that in the whole of London the only place satisfying these requirements is the Science Museum at South Kensington, where the public can see the transmissions every afternoon. No doubt many comparable institutions within the service areas of the present and of future transmitters would be willing to grant facilities for regular demonstrations. Even if reception conditions are not ideal in conveniently central situations, most of the difficulties could be overcome at a cost that would not be excessive for a co-operative effort. We suggest that in this effort both the industrial organizations and the B.B.C. might co-operate with advantage.

"STATIC"

THIS synonym for "atmospherics," "interference," or even sometimes "jamming," is a word which *Wireless World* tries to avoid. We were glad to see that a contributor, writing in our December issue, refuses to accept "precipitation static" as a term to describe corona discharge interference. Though this may have a static origin, conditions are anything but static when the interference manifests itself.

A misleading—if not meaningless—statement due to a mis-translation ascribable to the currency of the deplorable term "static" has just come to our notice—and in an official publication at that. Below are given short extracts from the parallel French and English texts in the report in the *Journal des Télécommunications** (Berne) on the Maritime Regional Radio Conference, Copenhagen. The italics are ours.

ARTICLE 12.

Les administrations prendront, en ce qui concerne leurs stations cotières, les mesures nécessaires: .....

(b) pour éviter toute émission *parasite* susceptible de causer des brouillages nuisibles.

ARTICLE 12.

With regard to their coast stations, administrations shall take the measures necessary: ....

(b) to avoid any *static* emission likely to cause harmful interference.

* September, 1948; p. 353.

Comment is hardly necessary, but we cannot help saying that the figurative French use of the word *parasite* for "interference" seems to be hardly less confusing than the Anglo-American "static," and to be even more to blame.

LOW-IMPEDANCE VARIABLE

The Cathode Follower as a D.C. Potential Divider

By M. G. SCROGGIE, B.Sc., M.I.E.E.

IN previous issues[1] the series type of voltage stabilizer has been considered in some detail. It is, as we have seen, essentially a cathode follower with amplified feedback. The amplification enables a very high degree of stabilization and absence of internal resistance to be achieved, but introduces difficulties when the output voltage is required to be variable below about + 100 V. It is also rather elaborate if several independently - variable stabilized outputs are to be provided.

The internal resistance of a plain cathode follower, being approximately $1/g_m$, is relatively high—of the order of 150Ω—but is nevertheless far lower than that of a potential divider across the main stabilized output, even if the resistance of the potential divider were made so low as to waste most of that output. The various types of Marconi "Stabilivolt" provide from one to four tappings, with internal resistance in some types as low as 40Ω, but are limited to certain fixed voltages, generally multiples of 70 V. Cathode followers, on the other hand, can be controlled to provide continuously variable outputs from nearly zero up to that of the main supply, are simple and cheap, and in most cases their internal resistance is less than 1 per cent of the load resistance and therefore practically negligible. They can be added to any existing stable-voltage unit, or incorporated in the design; so the whole becomes a very flexible equipment for laboratory use. The same idea has been applied in power units forming parts of equipment such as amplifiers, to supply constant screen-grid potentials, and was devised for that purpose by the late Dr. Partridge.[2]

Fig. 1 shows the very simple essentials of the "electronic tapping." The symbols have been chosen to fit on to those used in the previous articles dealing with the main unit. V_0 can therefore be assumed to be a stabilized output, variable, say, from 200 to 400 V. $R_{10}R_{11}$ is a wire-wound potentiometer of about 0.1 MΩ, controlling the tapping voltage, V_t. R_{12} is a grid-current limiter to take care of the valve under conditions when R_{10} and the load resistance, R_L, are low.

The question is, what sort of valve should be chosen? The answer quickly becomes clear if one takes any valve characteristic curves and uses them to calculate the performance. Short-circuiting preliminary bad guesses, let us start with a type that will turn out to be particularly suitable in most respects—the Mullard EC52. (This happens to be intended primarily for very high frequencies, up to 400 Mc/s, so it is perhaps not the most obvious choice for a zero-frequency application).

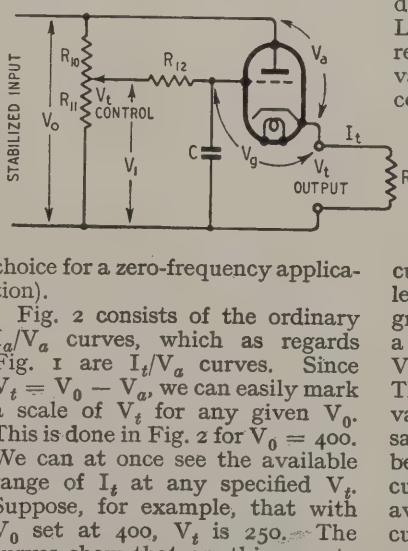


Fig. 1. Stable-voltage "electronic tapping," with output adjustable over nearly the whole range of V_0.

Fig. 2 consists of the ordinary I_a/V_a curves, which as regards Fig. 1 are I_t/V_a curves. Since $V_t = V_0 - V_a$, we can easily mark a scale of V_t for any given V_0. This is done in Fig. 2 for $V_0 = 400$. We can at once see the available range of I_t at any specified V_t. Suppose, for example, that with V_0 set at 400, V_t is 250. The curves show that anything up to 18 mA is available, at V_g from 0 to − 3.5. One has only to add this variable V_g to the specified V_t to get the relationship between I_t, the current drawn, and V_1, the setting of the V_t control (assuming no grid current to cause a drop in R_{12}).

What we want, of course, is not a curve of V_1 against I_t for a fixed V_t, but V_t against I_t (the so-called regulation curve) for any fixed V_1. Under these conditions, when V_g varies owing to a change in I_t drawn, V_a is altered by the same amount. But with a high-μ valve such as this ($\mu = 50$) the effect of the change in V_a is quite negligible. So far as the characteristic curves are concerned—in particular, the I_t/V_g relationship corresponding to any value of V_1—it is legitimate to disregard the difference between V_t and V_1, and to use the V_t scale as a scale of V_1.

Supposing for example that V_1 is set to 250 V, then; zero I_t is represented in Fig. 2 very nearly by point A, where V_g is −3.5, so the corresponding V_t must be 253.5, represented by point A′, set off to the left by a distance corresponding to V_g. Looking upwards from A, we can read off at intervals the decreasing values of $-V_g$ (and hence of V_t) corresponding to increasing load currents, and set them off to the left. The limiting point is where grid current starts to flow, causing a voltage drop in R_{10} and R_{12}. Voltage stabilization then fails. The start of the grid current varies from valve to valve of the same type, and in the EC52 lies between 0 and −1 V. The dotted curve at −0.5 represents an average, and in the assumed circumstances is met when I_t is 14.5 mA (point B).

From the way in which the regulation curve A′B has been derived it is obviously the familiar I_a/V_g curve (for $V_a = 150$ in this case), crowded on to the V_a

[1] Oct., Nov., Dec., 1948.

[2] *The Partridge Manual*, p. 16. (Partridge Transformers Ltd., Kingston By-Pass, Tolworth, Surrey).

VOLTAGE TAPPINGS

scale. That being so, it represents a resistance equal to $1/g_m$, confirming cathode-follower theory when $1/\mu$ is neglected. Thus, over the range 0 to 14.5 mA, the variation in output voltage is

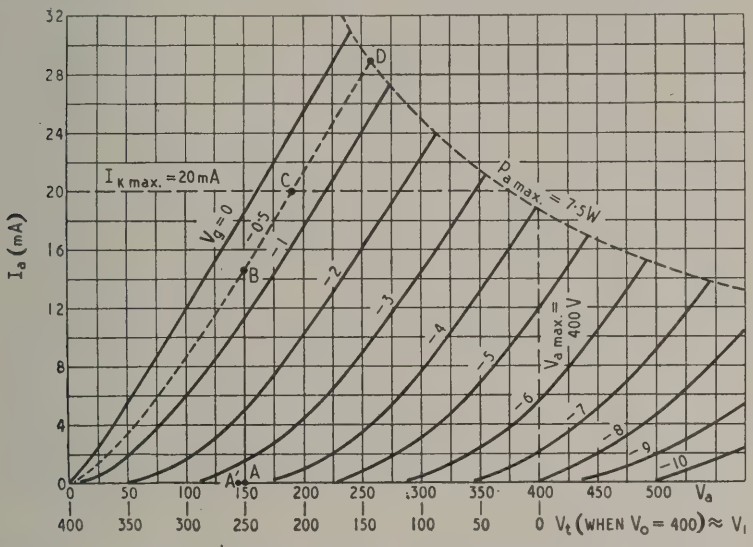


Fig. 2. I_a/V_a characteristics of EC52, illustrating properties and design of electronic tapping.

3 V. If this variation were uniform, it would indicate a generator resistance of 3/0.0145 = 207 Ω. Actually, as the curves show, it is greater than this for small I_t, and decreases to about 140 Ω in the region of $V_g = -1$.

Assuming that R_{12} is large enough to keep V_g constant at −0.5 V as I_t is increased beyond point B, we must now follow the dotted line. In due course this would bring us into the zone fenced off by the maximum cathode current rating for the valve (20 mA). If it were not for this, one could proceed as far as point D, on the boundary set by the maximum anode dissipation (7.5 W). With other valves or conditions, especially with low V_t, it is possible to strike the anode dissipation limit first. A third limit, maximum rated V_a, is shown as a vertical dotted line. Exclusion of the area to the right of it conservatively assumes that V_t is liable to go right down to zero.

If we prefer a regulation curve in the more usual form, with a vertical voltage scale, we can draw it as in Fig. 3, constructed from data transferred from Fig. 2. For preliminary purposes it should be enough merely to inspect the valve makers' curves turned through −90°. This is because the regulation curve comprises two regimes; the first, A'B, in which stabilization is effective, consists of the I_a/V_g curve for the appropriate V_a ($\approx V_0 - V_1$), and with a high-g_m valve is nearly level. The second, BC, follows (unless the I_{kmax} or p_{amax} limits have intervened) when the tapping is overdrawn so that grid current flows. If R_{12} were so large that further reduction in $-V_g$ could be neglected, this part of the regulation curve would coincide with the I_a/V_a curve for V_g corresponding to the start of I_g (the dotted curve OBCD in Fig. 2). There are practical disadvantages in making R_{12} large enough to approximate very closely to this assumption, so that I_a/V_t characteristic should not be expected to represent this part of the curve accurately. So far as regulation is concerned, that matters little, seeing that it is a condition one avoids; but it does slightly affect the risk of overrunning the valve. Experimental results (with R_{10} R_{11} = 0.1 MΩ; R_{12} = 0.25 MΩ) have been plotted in Fig. 3 for comparison. Whereas the difference between them and the theoretical plots is imperceptible over most of the flat part, the experimental curve slopes less steeply in the unstabilized condition.

Regulation curves for other settings of V_1 can very quickly be added to Fig. 3 if the corresponding I_a/V_g are available; failing which, the data can be derived from the I_a/V_a curves of Fig. 2 as previously. This exercise makes it clear that on open circuit the output voltage is equal to the V_1

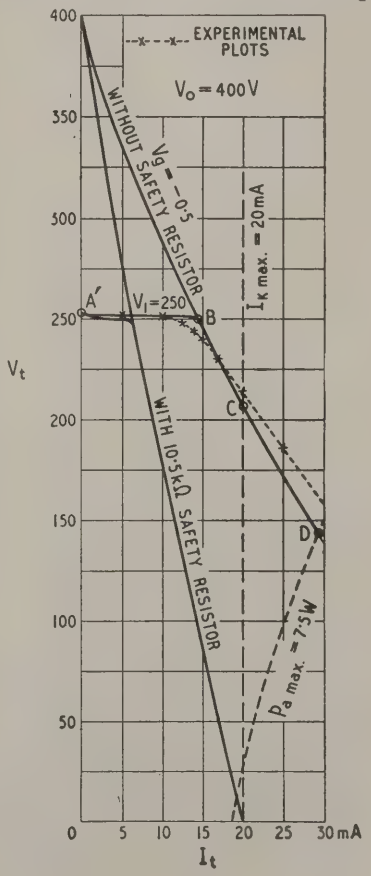


Fig. 3. Regulation curve, A'BC, derived from Fig. 2, with the voltage control set at V_1 = 250. An experimental curve is dotted in for comparison. The modification due to a fixed resistor in series with the anode, sufficient to prevent the rated limits from being exceeded under any conditions, is also shown.

Low-Impedance Variable-Voltage Tappings—

setting plus a voltage that ranges from practically zero when $V_1 = V_0$ to V/μ when $V_1 = 0$. The maximum stabilized output current increases from zero at $V_1 = V_0$ to approximately the zero-V_g anode current of the valve at $V_a = V_0$ when $V_1 = 0$, subject to I_{kmax} and p_{amax} ratings.

If V_0 is altered, V_1 obviously changes in proportion; and so (approximately) does V_t.

The relationship of output to load resistance can be examined by drawing the usual load line from the point $V_t = 0$, $I_t = 0$, to the working point, in either

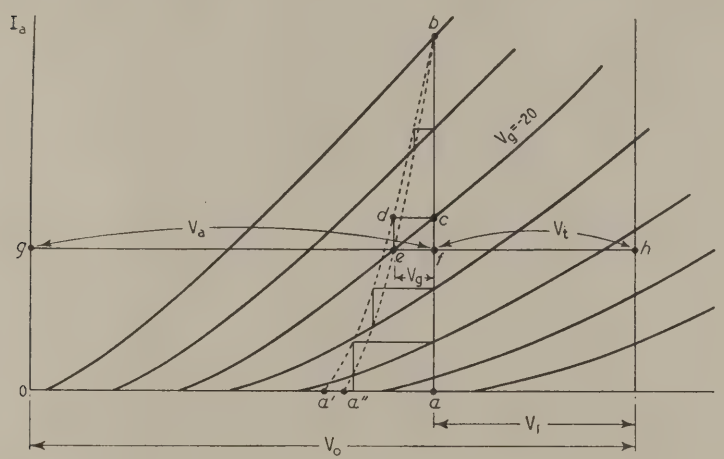


Fig. 4. Construction for drawing an accurate regulation curve, *a"b*, taking account of V_g being at the expense of V_a. *a'b* is the approximate curve of the type shown in Figs. 2 and 3.

Fig. 2 or Fig. 3. The output power is a maximum when the working point lies on the line $V_t = V_a$, at the highest permissible current.

The foregoing analysis has been based on the assumption that $\mu \gg 1$. This undoubtedly applies to the EC52, with a μ of 50; in fact μ has to be exceptionally small for the error to be significant. If it makes one happier to obtain the more exact result, it can be done quite easily, as shown in Fig. 4. Here *ab* is a vertical line representing the selected V_1. The approximate regulation curve, *a'b*, has been obtained as before, by setting off distances to the left of *ab* to represent V_g. Consider, for example, the curve marked $V_g = -20$, which crosses *ab* at *c*. Then if *cd*, drawn horizontally, represents −20 V on the voltage scale, *d* is a point on *a'b*. Dropping a vertical from *d* to meet the $V_g = -20$ curve gives a point on the accurate regulation curve, which, when completed, is *a"b*. The correctness of the construction can be seen by observing that *eg* represents V_a at the I_a and V_g considered, and $ef = dc = V_g$, so *fg* represents $V_a + V_g$, which is $V_0 - V_1$, and V_1 is thus represented by *fh*, *f* being on *ab*, which was drawn to mark V_1.

For most valves the difference between *a'b* and *a"b* is imperceptible on an ordinary curve sheet.

It should now be clear what sort of a valve one should look for to fulfil the requirements. If the most important need is good regulation, which can be reckoned in terms of low internal resistance, clearly high g_m is the most important feature. But of a number of valves having similar g_m, should preference be given to high μ or low r_a? We have already seen that high μ is convenient for design purposes, in that one can neglect the fact that V_g is obtained at the expense of V_a. And if one wants to be able to control the output voltage to practically zero, a high μ is again an advantage. Looking at Fig. 2, the output voltage when $V_0 = 400$ and $V_1 = 0$ is never higher than 8, even on open circuit; whereas with a low-μ valve of similar g_m (the Osram PX4, see Fig. 5) it is nearly 90 V. On the other hand, high μ means high r_a, which means that the current output at voltages not much below V_0 is very limited. Fig. 2 or 3 shows that with the EC52 the stabilized I_t from a tapping 100 V below V_0 is only about 8 mA, whereas the PX4 yields about 65 mA.

In estimating the current requirements, allowance must be made for any modulation of the mean current drawn. While the peak I_t can be allowed to overstep the p_{amax} and I_{kmax} limits (so long as the mean I_t or working point is within), it should not exceed the limits of stabilization, or unexpected effects may occur in the apparatus being fed.

When neither of these special requirements settles the μ question, the fact that high-g_m triodes are generally more easily obtained with low μ may be relevant. It must be remembered, however, that g_m is not constant, but decreases to zero as I_t is reduced. So if I_t is small relative to the maximum available, the nominally high-g_m valve may actually be inferior. For supplying, say, 5 mA, the EC52 would not only give a V_t much closer to the V_1 setting but would have a higher working g_m than the PX4, which would be under-loaded at that current. Alternatively one could keep clear of the bottom bend by using a shunt across the load.

Among other triodes which might be considered, there is the ECC32 with its two sections in parallel, totalling 10 W dissipation and 50 mA output but a lower g_m and V_{amax} than the EC52, and the ECC35 with $\mu = 68$ but maximum current only 16 mA.

A rather expensive but effective way of increasing the stabilized range of current, while retaining the high-μ advantages and reducing the internal resistance, is to connect valves in parallel. The performance is indicated by multiplying the I_t scale by the number of valves used.

One might ask, why not use a tetrode or pentode, seeing that there is a wider choice of these, and they offer high current, high g_m, and very high μ? The practical difficulty, which will be discussed later, is the need for keeping the screen grid at a constant voltage above the cathode. Such valves can be con-

nected as triodes, however. The clue to their triode μ, if it is not stated, is their μ_{g2-g1}, which is of the same order, and is beginning to be quoted more freely by valve manufacturers. It can be deduced from I_a/V_g curves, if they are shown for more than one V_{g2}, by noting the increment of V_{g2} needed to maintain constant I_a, per volt of V_g increment. The triode-connected Osram KT61 offers a useful combination of high g_m and high μ.

The valve's rated limits p_{max} V_{amax} and I_{kmax} must of course be taken into account. Unfortunately the published figures do not always include all three, and sometimes the voltage limit may seem lower than it need be on purely technical grounds. It is clear from the diagram that if V_0 is never greater than the V_a at which the zero-I_g bias line first meets a limit line (e.g. point C in Fig. 2) there is no need to worry about over-running the valve; the output terminals can be short-circuited at any setting of the V_1 control.

The valve can be made similarly foolproof for any higher value of V_0 by inserting in series with its anode sufficient resistance to drop the excess voltage. Suppose in Fig. 2 that the maximum V_0 is 400. Then the line representing the minimum fully safe resistance is the steepest that can be drawn from 400 on the V_a scale to meet the zero-I_g curve without crossing a limit boundary. In this case it joins point C; without the I_{kmax} limit it would have been D. The slope of the line shows that the resistor should be just over 10 kΩ and its maximum wattage 0.02 × 210 = 4.2.

Unfortunately such a resistor if fixed is in effect an increase in the valve's r_a so it degrades the performance correspondingly. The modified characteristics can easily be drawn by an obvious construction, in Fig. 3, shifting the points on the $V_g = -0.5$ curve downwards sufficiently to represent the voltage drop in the safety resistor. The "level" part of any regulation curve begins at the original point and meets the new curve at the same voltage, so obviously must slope more. It can be seen how seriously the current range is restricted at the lower settings of V_1.

As a compromise, to ensure safety when the widest possible range of adjustment is liable to be made in an experiment, but to retain maximum I_t and constancy of voltage in less severe conditions, the safety resistor can be made variable, from the safety value for maximum V_0, down to zero, and fitted with a scale marked in ohms and also in the value of V_0-V_t at which safety is assured. When the load resistance can be relied upon to be not less than the figure on the rheostat scale corresponding to V_0-V_1 equal to the maximum that will be used, the safety resistance can be turned to zero.

For $V_0max = 400$ in Fig. 2, the scale markings would be:

R(kΩ)	$V_o - V_t (= V_a)$
0	0–190
0.5	200
1.75	225
3.0	250
4.25	275
5.5	300
6.75	325
8.0	350
9.25	375
10.5	400

A suitable value for the resistor R_{12} is 0.25 MΩ, rated to take maximum V_0 across it. Lower values cause the valve to reach its rated limits sooner, while higher values tend to encroach on the "level" part of the regulation curve. Both these effects are illustrated to some extent by the experimental curve in Fig. 3.

There are at least three possible causes of hum in the output. The most straighforward of these is hum in the input, V_0. Regarding the arrangement as a cathode follower, and assuming $\mu \gg 1$, load resistance high, and grid current nil, it is easy to see that the proportionate unsteadiness in V_t is approximately equal to that in V_1, which in turn is equal to that in V_0. The errors in this approximation, due to load resistance and μ not being infinite, tend to cancel out. Since the main stabilized supply presumably is extremely smooth (e.g., in a unit designed on the lines described in the preceding articles it was 1 mV or less) this cause is not likely to be troublesome in practice.

A relatively enormous amount can be introduced via the heater, if the heater winding is not screened, and especially if it is wound next the H.T. coil. Permissible maximum heater-to-cathode voltage forbids the heater from being tied to a constant-potential point, except for very limited ranges of V_t; and the maximum heater-to-cathode re-

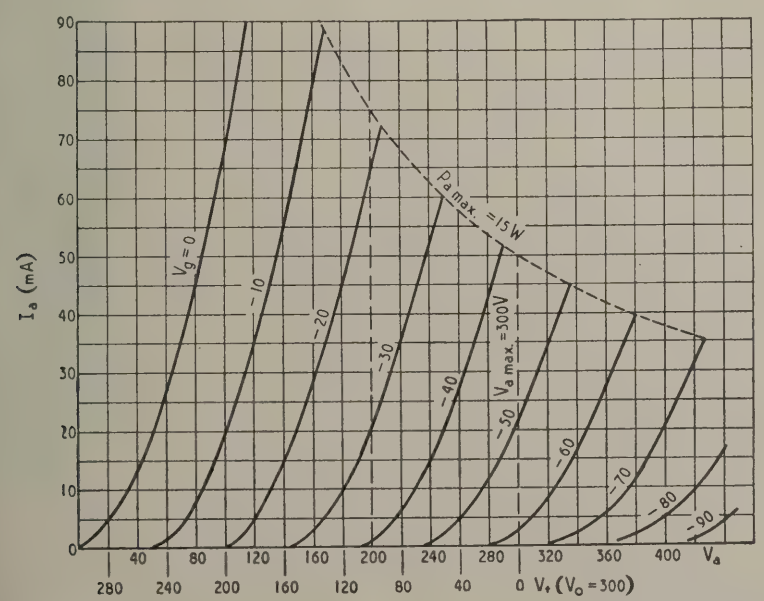


Fig. 5. Characteristic curves of low-μ valve (PX4), for tapping to provide relatively heavy current.

Low-Impedance Variable-Voltage Tappings—

sistance rating forbids one to leave it floating. So one is obliged to join the heater to cathode. Between the heater winding and any others there should therefore be a screen connected to the common negative point.

The grid circuit, owing to its high resistance, is sensitive to hum, and should be laid out so as to minimize pick-up. What is unavoidable can be reduced to a low level by about 1 or 2 μF connected to negative (C in Fig. 1). This confers the additional benefit of smoothing out contact irregularities as the voltage control is operated.

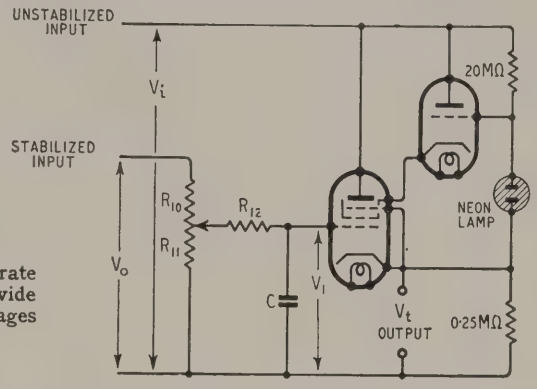


Fig. 6. A more elaborate type of tapping, to provide heavy current at voltages as high as V_o.

The overall hum is generally least at some middle setting of this control, depending on the load resistance. That is because, as already mentioned, the hum voltage increases in proportion to V_t towards the maximum V_t; and it also increases near minimum V_t because (with constant load resistance) the output current tends to be cut off, and with it the low cathode-follower output resistance which "holds down" hum.

In case it occurs to anyone to insert a voltage-calibrated milliammeter in series with the negative end of the voltage-control potentiometer for indicating the voltage of the main stabilized supply, it may be as well to point out that the reading is pulled down appreciably if the tapping valve runs into grid current.

The fact that the available current output falls off to zero as V_t is brought right up to V_0 may be a disadvantage. To get over it, the anode voltage must be supplied from a more positive point. The pentode (and tetrode) property of anode current being almost independent of anode voltage above a fairly low figure is an attractive one in this connection; especially such a valve as the Mazda 12E1, with rated limits at 35 W, 700 V, and 300 mA. The snag is constancy of V_{g2}. It is possible to provide it by means of an auxiliary cathode follower and neon tube, as in Fig. 6. An ordinary "beehive" lamp, without internal resistor, maintains about 160 V at currents of a few microamps, which are small enough not to cause serious trouble at the cathode end of the potential divider; and the resulting V_{g2} fits the 12E1 nicely.

This arrangement is rather tricky to design, however, and is subject to a number of limitations which make it not entirely suitable for general use. It is not easy to find a cathode follower valve rated to stand the anode voltage when V_t is low, nor to arrive at values of the potential-dividing resistors that are satisfactory over wide ranges of V_t and I_t. If low values of V_t are ruled out, one might as well revert to series stabilization, with its much better performance.

Nevertheless it is mentioned, because it might be quite useful in special circumstances.

ELECTRONIC MOISTURE CONTROL

Manual or Fully Automatic Operation

THE customary method of judging the degree of dryness of textiles during manufacture is by feel. Human judgment being far from infallible, electronics has now stepped in and apparatus is available for giving a more exact measure of the moisture content during the drying process.

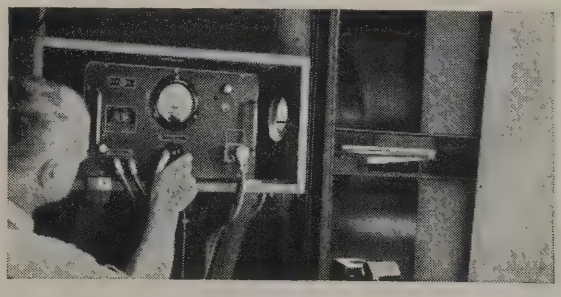
The Fielden Drimeter can be used with any type of textile drying machine in which the material passes at a pre-determined speed between drying elements.

Operation of the Drimeter is based on the fact that the dielectric constant of the material passing between two flat electrodes varies with its moisture content. Thus by constantly monitoring the capacitance of these electrodes variations can easily be converted into changes in current and applied to a visual indicator.

The equipment is first set up by inserting a sample of material, dried to the desired degree, between the electrodes and setting the pointer of the indicating meter to a pre-determined zero. A knob is provided on the unit for this purpose. Alternatively, a moisture calibrating unit can be employed.

When the drying machine is in operation it is then only necessary to regulate its speed so that the needle of the indicator remains steady. The Drimeter can be supplied either with the indicating meter built-in or on a separate unit including the adjusting knob.

A more recent development is the production of a companion unit which gives full automatic control of the drying process. Control is electronic and the operating voltages are derived from the Drimeter and also from a small alternator driven off the main shaft of the machine.



Fielden Drimeter with indicator and control embodied in a single unit.

It functions on the difference principle and produces a voltage that is applied to an electric motor which operates the speed control mechanism of the drying machine.

The equipment is made by Fielden (Electronics), Ltd., Holt Town Works, Manchester, 10.

"Q" METERS

Function and Application

By H. G. M. SPRATT,
B.Sc., M.I.E.E.

AT his desk the radio engineer is, perforce, a purist. He precisely separates, and maintains separated, his inductances, capacitances and resistances. It is the most convenient basis for his calculations and, as frequencies rise, he clings to it until defeated by an invasion of lines, waveguides and resonant cavities.

At the bench, however, such an attitude is impossible. His Cs have some L, his finest R always contains L and C as trace elements, but, most annoying of all, his L always has some R. Furthermore he cannot separate these quantities physically. Yet, in most cases, he must determine their separate values if his design is to go forward.

On the average, of all components, inductors fall farthest short in their standard of purity and so, whenever a high-quality tuned circuit is required, the primary consideration is the goodness of the coil. Now it is not an easy task, and certainly not a speedy one, to measure directly and accurately the inductive and resistive components of any arbitrary coil at any arbitrary frequency with simple radio apparatus. As a result, the Q meter has been evolved, an instrument designed for the express purpose of effecting this by what is known as Q measurement.

Fundamental Considerations

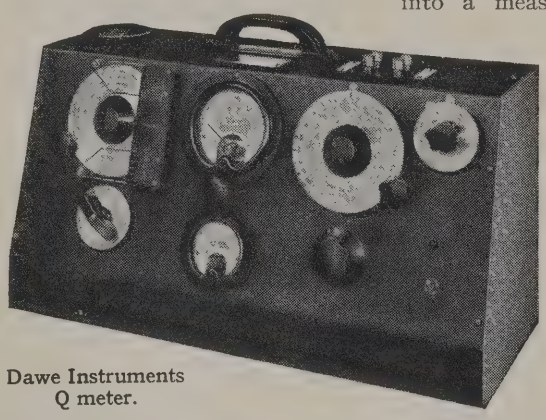
The fundamental definition of the Q-factor of any component is the ratio

$$\frac{\text{Energy stored}}{\text{Energy dissipated}}$$

and this is applicable to all components and conditions. In ultra-high-frequency circuits, where inductance, capacitance and resistance are distributed throughout each component, it is indeed the only definition, but at lower frequencies, where lumped components are involved, it is convenient to convert this ratio to the more practical form,

$$Q = \frac{\text{reactance}}{\text{resistance}}.$$

Furthermore, since, as suggested above, the limiting factor in the majority of tuned circuits is the goodness of the coil, it is usual to ignore the Q of the capacitor and consider that of the inductor alone, namely $\omega L/R$. Now $\omega L/R$ is the ratio of the voltage developed across the coil inductance in the tuned circuit to the voltage injected in series with the circuit and is what used to be termed the circuit magnification. It is essentially this circuit magnification which is measured by the Q meter, though such a term is hardly appropriate when applied outside the realm of coil measurement. Nevertheless, the fundamental nature of the measurement is such that it is applicable not only to coils and inductances, but to any electrical element which has both a reactive and a resistive component. It, therefore, applies to virtually all electrical elements.



Dawe Instruments Q meter.

The Q meter, intended primarily for coil measurements, naturally does not cover infinite ranges of frequency, reactance or resistance. Nevertheless, the ranges usually provided are so wide and the versatility of this instrument so great, that several other important uses have been found for it. It is perhaps obvious, from what has already been said, that if the Q measurement of coils is possible with it, the same should apply to capacitors. What is not so obvious is that the technique can be extended to the determination of the characteristics of transmission lines, the residuals of resistors and the dielectric constant and power factor of insulating materials and the like, the last named being an enormous field by itself.

There is a number of methods of measuring Q but one only has found favour in the majority of Q meters as manufactured and marketed today. Considering the case of a coil measurement, an oscillator injects a known voltage into a measuring circuit. This measuring circuit includes a calibrated low-loss variable capacitor, the resonant circuit being completed by the component under test. A calibrated valve voltmeter is connected across the variable capacitor and the circuit tuned to resonance; i.e., to maximum voltage reading. Then this maximum voltage reading is a measure of the Q of the component.

This method has for a start the great advantage of speed. In the case of a coil measurement, one reading only is needed, and that reading is the Q itself. Other components may demand more than one measurement and one reading but the method is still a quick one. Accuracy is, of course, dependent upon the absolute calibration of the meter but in the rare case where extreme accuracy is essential, the instrument can be used as it stands to measure the Q by another method, a lengthier one in which the resonance curve is plotted and in which the important factors are the accuracy of the capacitor

"Q" Meters—

calibration and the relative accuracy of the meter calibration.

Main Design Details

The modern Q meter is designed to cover a wide frequency range, generally from 50 kc/s up to at least 50 Mc/s, this coverage being, of course, effected by coil switching. In addition provision is often made for connection to an external oscillator, should operation at still lower frequencies be desired. Coupled to the oscillator coil is a second circuit consisting of a thermo-ammeter and a very small non-inductive resistor, this resistor forming part of the measuring circuit as well.

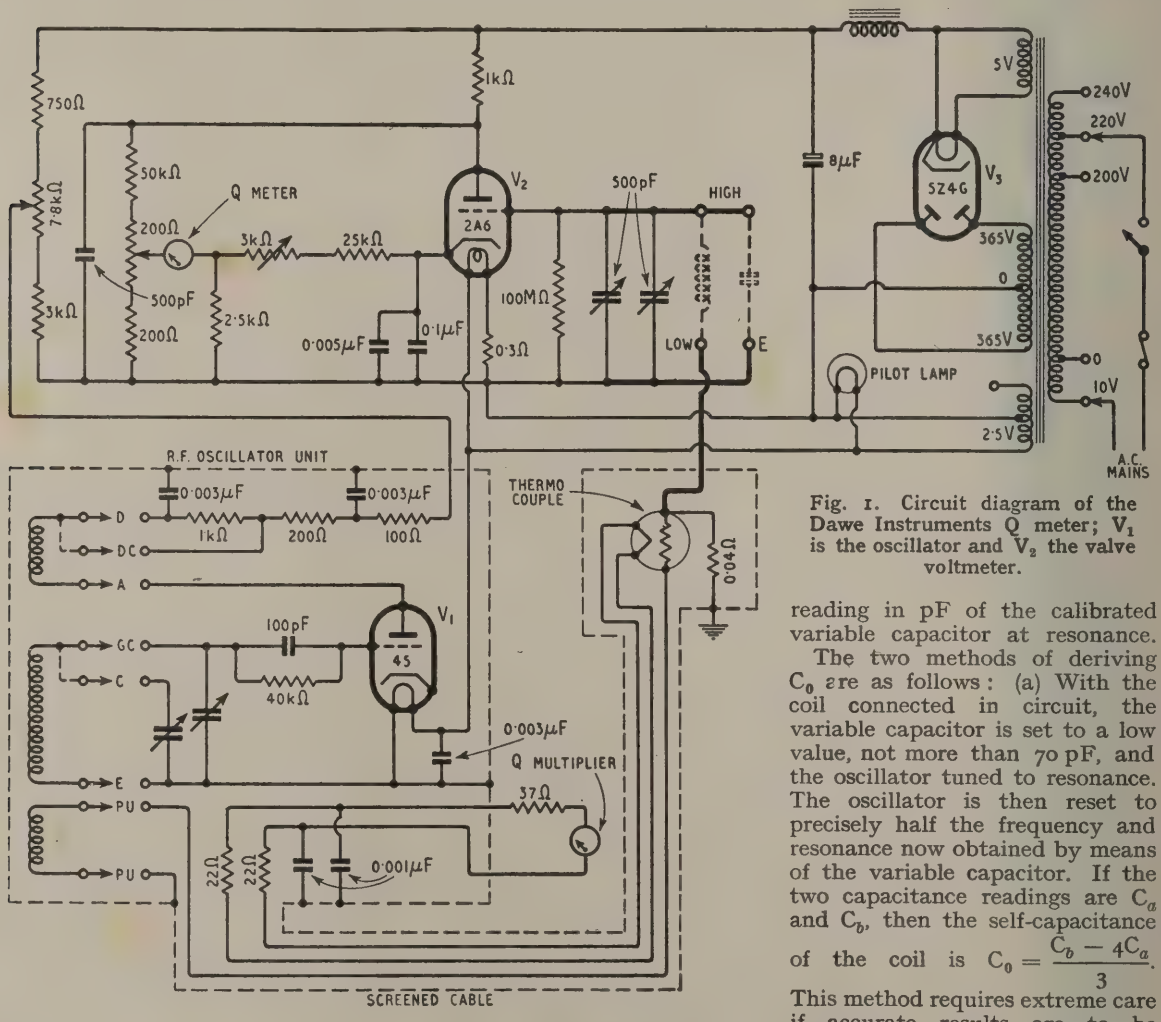


Fig. 1. Circuit diagram of the Dawe Instruments Q meter; V_1 is the oscillator and V_2 the valve voltmeter.

(See Fig. 1). Thus the measuring circuit has injected into it a small but definite voltage across an extremely small resistance of an amount which is negligible, except where high Q values, particularly at the higher frequencies, are involved. A correction for this small resistance in the circuit can easily be made where considered justifiable, as is shown later.

The measuring circuit also includes the calibrated variable capacitor, terminals for the connection of test components in series and parallel and the valve voltmeter. The latter must cover a wide voltage range, have a low input admittance and maintain a fixed calibration over the whole frequency range. The voltmeter circuit used depends upon the individual preference of the manufacturer.

The measurement of a normal coil is carried out by connecting it across the series terminals and adjusting the oscillator frequency and voltage level to the correct values. The variable capacitor is then tuned to resonance at this frequency and the Q value read directly off the meter. This is the effective Q, which is adequate for most purposes, but whose value differs slightly from that of the real Q owing to the fact that the self-capacitance C_0 of the coil has not been taken into account. There are two easy methods of determining C_0 on the Q meter itself and then the true Q can be determined from the equation—true Q = effective Q $(1 + C_0/C_1)$ where C_1 is the reading in pF of the calibrated variable capacitor at resonance.

The two methods of deriving C_0 are as follows: (a) With the coil connected in circuit, the variable capacitor is set to a low value, not more than 70 pF, and the oscillator tuned to resonance. The oscillator is then reset to precisely half the frequency and resonance now obtained by means of the variable capacitor. If the two capacitance readings are C_a and C_b, then the self-capacitance of the coil is $C_0 = \frac{C_b - 4C_a}{3}$. This method requires extreme care if accurate results are to be obtained.

In method (b) readings, with the coil connected, are taken of

resonant frequency f_c and capacitance C_c with C_c at about 400 pF. The test coil is then removed and resonance obtained with a shielded coil of 1/20–1/30 the inductance of the test coil at a frequency f_d, about 10 times f_c. When resonance has been obtained, the test coil is connected in parallel and resonance again sought. If the tuning capacitance has to be changed, the oscillator frequency must be changed, (an increase in frequency for an increase in capacitance), the test coil removed, the shielded coil re-resonated and the effect on tuning again observed when the test coil is replaced in parallel. This process is continued until no change in tuning capacitance is required when the test coil is included in the circuit. At this frequency, f_d, the test coil is self-resonating and its self-capacitance C_0 is given by—

$$C_0 = \frac{C_c}{(f_d/f_c)^2 - 1}$$ which for most cases $\approx (f_c/f_d)^2 C_c$.

From the above data the true inductance L_t of the coil can be obtained from the formula

$$L_t = \frac{25{,}300}{f^2 C_1 (1 - C_0/C_1)} \quad [\mu H, \text{pF, Mc/s}]$$

This takes account of the self-capacitance of the coil. The effective inductance L_e at the frequency f_1 is given by the simpler formula

$$L_e = \frac{25{,}300}{f^2 C_1} \quad [\mu H, \text{ pF, Mc/s}]$$

Similarly the true series resistance of the coil R is given by

$$R_s = \frac{159{,}000}{f C_1 Q} \cdot \left(\frac{C_1}{C_1 - C_0}\right)^2 \quad [\Omega, \text{ pF, Mc/s}]$$

and the effective resistance R at the frequency f by

$$R_e = \frac{159{,}000}{f C_1 Q} \quad [\Omega, \text{ pF, Mc/s}]$$

As suggested above, in the case of high Q values at high frequencies the additional accuracy obtained by correcting for the internal resistance of the measuring circuit may be desirable. This is effected as follows: If the value of the internal resistance is R_i, (generally 0.05 Ω or less), the net coil resistance is $R_s - R_i$. Then the absolute Q_a of the coil is

$$Q_a = \frac{6.28 f L_t}{R_s - R_i} \quad [\mu H, \Omega, \text{Mc/s}]$$

All these measurements can be carried out and the values determined in a similar manner in the case of low-inductance coils by introducing a larger coil and taking measurements on it with and without the small coil in series.

Capacitors

Measurements on small capacitors are carried out by introducing a suitable coil to complete the tuned circuit and then taking

Dawe Instruments production Q tester.

readings with and without the test capacitor connected across the internal calibrated capacitor, the setting of the latter being adjusted to resonance as required. If the readings taken are C_1, C_2 and Q_1, Q_2 then the capacitance of the test component is $C_1 - C_2$;

its Q value $= \frac{(C_1 - C_2) Q_1 Q_2}{C_1 (Q_1 - Q_2)}$

and its power factor

$$\approx \frac{100 C_1 (Q_1 - Q_2)}{(C_1 - C_2) Q_1 Q_2}$$

Other formulae will give the values of the effective series and parallel resistances.

For the highest accuracy when dealing with small capacitors of high Q, an external standard variable capacitor can be introduced into the measurement, the internal variable capacitor being left untouched throughout the measurement.

Limitations on measurement of capacitors are set by the high order of Q value associated with the components. Whereas the Q value of coils can be expected to range from 100—500 the corresponding values for capacitors will be 1000–6000 and even higher for high-quality air components. A value of 6000 will be about the highest that can be measured on most commercial Q meters. Most Q measurements on capacitors involve the determination of small differences between two comparatively large quantities and reasonable accuracy can only be obtained by taking careful measurements.

Another limitation is size, but capacitors above 400 pF up to about 0.1 μF can be measured by connecting them, in series with a small coil, across the coil terminals. Measurements are then made with and without the capacitor short circuited and appropriate formulae enable the Q, R and power factor figures to be determined.

Resistors

Two ranges of resistance values can be measured without difficulty on the Q meter, namely, the ranges corresponding to the normal effective series and parallel resistances of coils within the Q range of the instrument. Thus resistors of about 1–30 Ω and 0.1–2.0 MΩ are dealt with by connecting them in series with a suitable coil or in parallel with the internal capacitor of the Q-meter instrument. Measurements are taken with the resistor in and out of circuit and the resistive and reactive components derived from the results. Thus, suppose we are concerned with a resistor of about 20 Ω. A suitable coil is connected to the instrument and resonance obtained at the desired frequency f, giving readings of C_1 and Q_1. The resistor is then connected in series with the coil and readings again taken, giving values C_2 and Q_2.

Then the effective series resistance of the resistor is

$$159{,}000 \frac{Q_1 C_1 / C_2 - Q_2}{f C_1 Q_1 Q_2} \quad [\text{pF, Mc/s}]$$

If C_2 is less than C_1 the effective reactance of the resistor is inductive, the inductance being equal to

$$25{,}300 \frac{C_1 - C_2}{f^2 C_1 C_2} \quad [\text{pF, Mc/s}]$$

If C_2 is greater than C_1, the reactance is capacitive, the series capacitance being $\frac{C_1 C_2}{C_2 - C_1}$.

The Q factor of the resistor can be determined but its value is seldom of interest.

A figure of much greater import-

"Q" Meters—

ance is the time constant, given by L/R or RC measured in henrys, ohms and farads, and obtainable direct from the above data. The higher range of resistance values is dealt with in a similar fashion only here measurements are made with the resistor first out of circuit and then connected in parallel with the capacitor.

The measurement of the dynamic resistance of a parallel-tuned circuit is merely a variant of the measurement of a high resistor. With a suitable coil connected to the Q meter, resonance is obtained at the desired frequency f, giving values C_1 and Q_1. The tuned circuit is then connected across the capacitor terminals and itself tuned to give resonance again. If the altered value of Q is Q_2, the dynamic resistance value is:

$$\frac{0.159 Q_1 Q_2}{f C_1 (Q_1 - Q_2)} \quad [\text{pF, Mc/s, M}\Omega]$$

Insulating and Dielectric Materials

The essential qualities of these materials are revealed by the dielectric constant and the power factor, these parameters usually being determined by arranging for the material under test to form the dielectric of a capacitor. There are standard recognized procedures recommended for effecting this and it is not proposed to discuss them in detail. One method is to use mercury electrodes, while in another a sheet of the material is thinly coated with petroleum jelly and tinfoil of appreciably less area pressed down on both sides. In the case of a liquid a suitable vessel has to be constructed. Whatever method is followed, edge effects must be avoided by a generous margin of uncovered material around the edge of the sample. Suitable leads are fitted to the electrodes and taken to the capacitor terminals of the Q meter. The sample is then measured as a capacitor at the desired frequency. If the capacitance of the sample determined in the way described above is C pF the thickness d cm, the covered area A cm², then the dielectric constant $\epsilon = \frac{11.3Cd}{A}$.

The Q and, hence, the power factor are determined by taking measurements as described above for small capacitors. Then

$$Q = \frac{(C_1 - C_2)\, Q_1 Q_2}{C_1 (Q_1 - Q_2)}$$

and the power factor $\approx 100/Q$.

Transmission Lines

There are two methods by which transmission-line constants can be determined with the Q Meter. In the first, the frequency in c/s is fixed and a line length l metres, less than $\lambda/8$, is chosen. With the far end open circuited, the capacitance C_0 in farads and resistance R_0 in ohms are measured following the usual procedure for small capacitors. The resistance value is then transformed into the equivalent conductance G_0 mhos. With the far end short-circuited, the line is now measured as a coil and its inductance L_s henrys and series resistance R_s ohms measured. Then the characteristic impedance

$$Z_0 = \sqrt{\frac{R_s + j2\pi f L_s}{G_0 + j2\pi f C_0}} \quad [\Omega]$$

or for low values of R_s and G_0

$$Z_0 = \sqrt{L_s/C_0}$$

The attenuation A is given by

$$\frac{1}{8.69 \times 2l} \times \frac{G_0 Z_0 + R_s/Z_0}{1 + (2\pi f)^2 L_s C_0}$$

db per metre

and the velocity of propagation by

$$\frac{2\pi f C l}{\tan^{-1} \omega \sqrt{L_s C_0}} \text{ metres/sec.}$$

The second method avoids the measurement of very small or large reactances and enables any length of line above $\lambda/4$ to be used. With a line of length exactly $\lambda/8$ or an odd multiple of it, the numerical value of the reactance is equal to the characteristic impedance, being positive or negative depending upon the multiple and whether the far end is open or short circuited. The line is connected to the Q meter as a capacitor and the frequency adjusted until the capacitance on short and open circuit are equal and opposite in sign.

Then $Z_0 = \frac{1}{\omega \sqrt{C_s C_0}}$ [Ω, c/s, F]

At even multiples of $\lambda/8$ the input impedance becomes a very high or very low pure resistance, depending again upon the multiple and whether the far end is open or short circuited.

By adjustment of the Q-meter frequency a high-resistance condition is selected and this high resistance R_L measured.

The attenuation is then given by

$$A = \frac{Z_0}{8.69\, R_L l} \text{ db/metre}$$

If in one of these measurements the frequency is f and the number of $\frac{1}{8}$ wavelengths n, then the velocity of propagation is

$$v = \frac{8lf}{n} \text{ metres/sec.}$$

Conclusion

The measurements which have been described are now recognized as well within the capabilities of the Q meter and are treated as standard practice. No doubt additional uses will be found from time to time. The outstanding advantages of the instrument throughout are its wide frequency ranges, direct reading features and ease and speed of operation. The last two features have led to the appearance of a modified form of Q meter, generally known as the Q Comparator. It is intended for repetitive and comparison testing and has in consequence been simplified by the removal of the thermoammeter, although the constancy of the injected voltages is still assured.

OUR COVER

A 27-in circular mirror and an 18-in diameter plastic correcting plate is incorporated in the television projector illustrated on the front cover. This equipment, which has been developed by Cinema-Television Ltd. for use in cinemas, operates on 405 lines with an anode voltage of 50,000. Experimental equipment has been in operation in a cinema in Bromley, Kent, for some time and it is hoped to give a description of the equipment and the proposed method of linking London cinemas in a future issue of *Wireless World*.

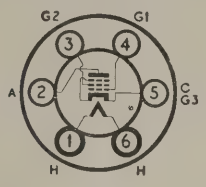
For a resounding Christmas

BRIMARIZE

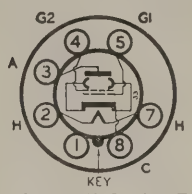
TYPE 89 is a low consumption output pentode used mainly in car radio receivers. It may be replaced most conveniently by type 41, or with change of socket, by type 6K6G. Type 6V6GT may also be employed together with change of socket and bias resistor.

89

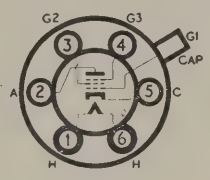
PUNCH HOLES HERE



Type 41



Types 6K6G, 6V6GT



Type 89

CHARACTERISTICS

	TYPE 89	TYPES 41, 6K6G	TYPE 6V6GT
Heater Voltage	6.3	6.3	6.3 volts
Heater Current	0.4	0.4	0.45 amp.
Anode Voltage	250	250	250 volts
Anode Current	32	32	32 mA
Grid Bias	−25	−18	−15 volts
Cathode Resistor	680	470	390 ohms
Optimum Load	7000	7500	7500 ohms
Power Output	3.4	3.4	3.3 watts

CHANGE VALVE		CHANGE SOCKET		CHANGE CONNECTIONS		OTHER WORK NECESSARY	PERFORMANCE CHANGE
FROM	TO	FROM	TO	FROM OLD SOCKET	TO NEW SOCKET		
Type 89	Type 41	U.X. 6 pin	No Change	Pin 1 „ 2 „ 3 „ 4 „ 5 „ 6 Top Cap	Pin 1 „ 2 „ 3 Disconnect Pin 5 „ 6 „ 4	Change bias resistor if necessary. The correct value for type 41 or 6K6G is 470 ohms 1 watt	NEGLIGIBLE
89	6K6G	U.X. 6 Pin Int. Octal.		Pin 1 „ 2 „ 3 „ 4 „ 5 „ 6 Top Cap	Pin 2 „ 3 „ 4 Disconnect Pin 8 „ 7 „ 5		
89	6V6GT	U.X. 6 Pin Int. Octal.		As for Type 6K6GT		Change bias Resistor to 390 ohms 1 watt See NOTE.	HIGHER SENSITIVITY

NOTE.—In 12-volt receivers where the heater of the 89 is connected in series with one of the other valves a balancing resistor may be required in the heater circuit.

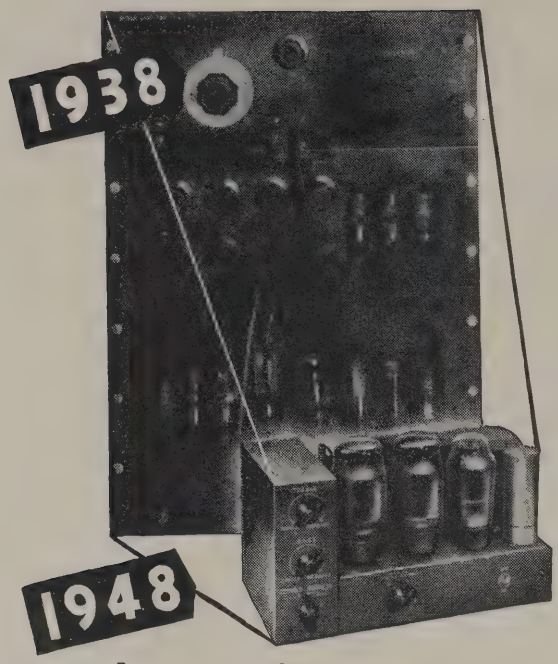
BRIMAR says
BEST WISHES AND
BETTER LISTENING

BRIMAR
RADIO VALVES

STANDARD TELEPHONES AND CABLES LIMITED, FOOTSCRAY. SIDCUP, KENT.

INSTRUCTIONS: Punch holes where indicated and cut away this portion. Cut out and file them in the order in which they appear. This column will then give you a quick reference index.

22



Evidence of PROGRESS

The illustration above shows an ACOUSTICAL product of ten years ago—an amplifier designed for high quality reproduction of records and radio programmes.
Using push-pull triodes throughout—RC coupled throughout—independent treble, middle and bass controls etc., it was considered about the best that could then be obtained. Indeed the circuit is often specified today for high quality reproduction.
A comparison of the performance with that of the QA12/P reveals the extent of recent developments.

	Pre-War	QA12/P	Improvement achieved
Output deviation within 20-20,000 c.p.s. range ...	3 db	0.3 db	7 times better (% power change).
Frequency range within ± 1 db ...	30–15,000 c.p.s.	15–30,000 c.p.s.	Increase of two octaves.
Total distortion at 10 watts (Both models rated 10–12 watts).	2%	0.1%	20 times less distortion.
Sensitivity (r.m.s. for full output) ...	0.2 v	0.0015 v	120 times more gain with no background increase.
Background noise (equivalent r.m.s. at input)	120 microvolts	1 microvolt	
Background for equal (low) gain	—65 db	—80 db	15 db lower background.
Load impedance Internal Impedance	2	12	Better damping.
Treble and bass controls	variable extent of boosts and cuts	variable slope of boosts and cuts.	Wider range of control and slopes of controls more accurately designed for small room listening conditions.
PRICE ...	£60	£30	50% less cost.

ACOUSTICAL

Acoustical Manufacturing Co., Ltd., HUNTINGDON. *Tele.: Huntingdon* 361.

A poor life this
if full of care,
You end with voltage
through your hair,

No time to sing
and dance and play,
Because your volts
aren't under way.

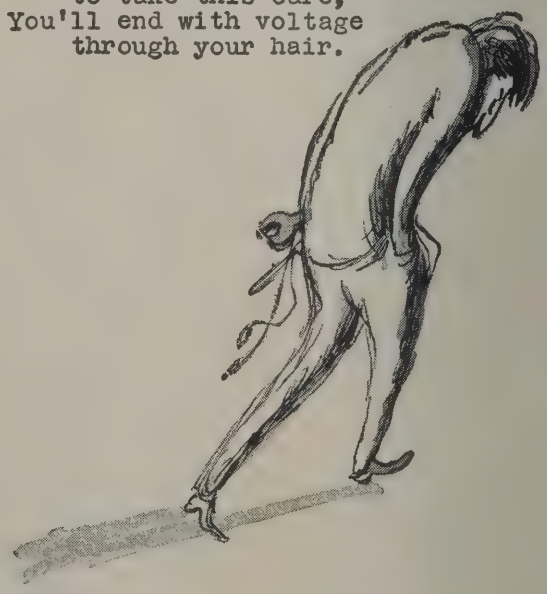
No time to step out
just because,
Your step-up system's
full of flaws.

No time because
tests have revealed,
That your Transformers
are not sealed.

'Gainst moisture - cold -
vibration - dust -
Heat - humidity and rust,
Fumes and fungus, sudden shocks,
Altitude and hearty knocks.

No time to seal
hermetically,
As Mercury
emphatically.

If you've no time
to take this care,
You'll end with voltage
through your hair.



PARMEKO of LEICESTER

Makers of Transformers for the Electronic and Electrical Industries

DISTORTION: DOES IT MATTER?

Further Discussion by the I.E.E. Radio Section

AT a meeting of the Radio Section of The Institution of Electrical Engineers on Tuesday, 9th November, 1948, P P. Eckersley re-opened a discussion on "To What Extent Does Distortion Really Matter in the Transmission of Speech and Music?"

He began by saying that the overall impression left by the first discussion[1] on the subject was that none of us knew a great deal about the subject, but many found it as engrossing as ever. Two questions still remained to be answered, namely, was it worth while to try to find out more and, if so, what line of attack against obscurities would be the best?

Although the final judgment of a transducer must be subjective, surely much could be learned by objective tests. For instance, the fact revealed, as we were told, by measurement, that the loudspeaker generated harmonics, should stimulate someone to produce an instrument that did not. Then the ear would judge whether the improvement in eliminating harmonics and combination tones were substantial. Further experiments with audiences listening to live performances, the sounds of which were modified artificially, ought to tell us a great deal more about what to aim for. Precise information could thus be obtained about the preferences of the ear.

Artificialities

This led to observations concerning a misunderstanding that was revealed during the previous discussion regarding certain suggestions made in the opener's previous remarks, namely, that in the presence of inevitable artificialities due to the circumstances of reproduction of broadcast programmes and gramophone records, other artificialities might, with advantage, be introduced. The object of these suggestions was that the impact of the reproduction upon the senses might be the more certain to "evoke emotion" in the hearer than if an exact copy of the original were reproduced. Some speakers seemed to imagine that he proposed a wholesale cutting away of parts of the spectrum. There was, in fact, no proposal, explicit or implicit, to perform any major operation upon the spectrum, but rather, as in beautifying by plastic surgery, to reduce exaggerated features and to encourage those that were weak. By such methods, the reproduction should gain in beauty, even though the means to that end were artificial.

[1] Reported in *Wireless World*, March, 1948.

Judges of Quality

Turning to detail, the dispute about the competence of musicians to judge loudspeakers was not resuscitated in the introduction, but it was raised apparently from the dead, during the discussion. It was revealed that B.B.C. engineers had discovered that certain of their musical colleagues could not form useful judgments on the qualities of loudspeakers. This was a limited discovery. Pursued a little further, it would be found that some musicians had sensibilities which transcended those of some technicians. Continued research would reveal that the co-operation of each person, according to competence rather than trade or calling, would be of greater benefit than the dismissal of one class of persons by ill-considered generalities.

This second introduction, bridging the two discussions, must once more stress the importance of providing better transmission facilities. As it was, the best of loudspeakers had no value since the conditions of radio transmission and often the background noise on gramophone records, made it impossible to use the upper parts of the audio spectrum. Thus, while there was no demand for a good loudspeaker because the lower and middle register sufficed to give pleasure to most ears, there would, in the face of the poor transmission facility, be not much use for it even if it existed.

The contention remained that, if transmission facilities were improved, an insistent demand would be created for a better reproducer. For nearly 30 years we had used the same type of radio transmitter and for 20 years the same type of receiver had cut off more and more of the spectrum broadcast at greater and greater levels. A solution of the problem of programme distribution, be it by frequency-modulated transmission or by the use of the much simpler wire networks to link microphone and transmitter, would put us on the way to find out which distortions did and which did not matter. We might also discover, in terms of a widespread high-fidelity service, how to shape an artificial spectrum for the greater benefit of the art of sound reproduction.

Heresy

The discussion which followed was by no means restricted to the technical and engineering aspects of transmission and reception. Valuable contributions came from representatives of the programmes department of the B.B.C., who put forward what to high-fidelity purists must have seemed paradoxical, not to say heretical views. In the broadcasting of eye-witness accounts the presence of considerable distortion, it was contended, would not only be tolerated by the listeners but would convey an atmosphere of actuality and excitement which could not be put over if the transmission had the impeccable quality of a studio broadcast. Even when distortion was so bad as to threaten intelligibility, there was still justification for re-broadcasting, for example, Mr. Churchill's speeches from the other side of the Atlantic.

In the broadcasting of symphonic music the best place for the microphone was not, according to one

Distortion : Does It Matter?—

speaker, just above the conductor's head, or, indeed, any position which faithfully reproduced the sound in the immediate vicinity of the instruments. The experienced concert-goer did not like his oboe "neat," but always chose, if he could, the 10th or 20th row back, where the higher-order harmonics were to some extent absorbed. Too much "top" was often associated with what musicians would dismiss as a bad hall. Often it was also a symptom of faulty tone production, which would incur the conductor's displeasure; yet engineers were always trying to preserve what the musician wished to get rid of.

Atmosphere

Support for this view was given by an authoritative statement that broadcasts of the Scottish Orchestra, which met with wide approval among the musically informed, were restricted to an upper frequency of little more than 6,000 c/s; but the acoustics of the studio were exceptional. This quality, which might be likened to the background scenery and lighting of a stage presentation was largely fortuitous; we could avoid the grosser errors in studio design and reduce the bad effects of existing halls by placing the microphone closer to the performers, but much remained to be learned before the creation of naturalness, perspective and "atmosphere" could be described as a known art.

One speaker thought that the comparatively simple task of reproducing the voice of a solo artiste with naturalness had not yet been solved, and suggested that the "invention" of the crooner was an engineer's subterfuge to circumvent this particular problem. Musicians often tried to persuade those responsible for "Balance and Control" to place the microphone farther away, "because it sounds better," but they did not always appreciate that an estimate of the optimum distance made by direct listening would not hold for the microphone, which was a monaural device and would make the reverberation components of the sound seem more pronounced. It was for this reason that the engineers insisted on bringing the microphone closer to the performer.

Few listeners took much trouble to improve the acoustic background of their rooms. It was true that the scope for such treatment was limited, and one speaker revived the suggestion that high-quality headphones might solve the problem when conditions proved intractable.

It was agreed that comparisons of quality, using as a reference standard the sound that one imagined would come from the mouth of the loudspeaker if it were, in fact, an aperture in the wall separating the living room from an adjacent concert hall—the "Pyramus and Thisbe" theory, as the opener put it—could be of value in judging the performance of equipment; but the opinion of those who had had actual experience of listening to "live" performances under these somewhat unusual conditions was that the quality was far from satisfying and not much to be desired.

The æsthetics of listening covered such a wide field, and tastes were so varied that in the opinion of some speakers the B.B.C.'s function should not extend beyond the transmission of a "facsimile" of the original. It should then be left to the listener to modify this by tone and volume controls "according to his perversity." The difficulties of sustaining a wide audio-frequency spectrum on programmes of varied origin was recognized and a plea was made for adequate top cut at the source when intermodulation distortion, which would be at once revealed by modern high-grade loudspeakers, could not be avoided. One speaker thought that binaural transmission would be a more welcome development than efforts to extend the higher frequency response.

Physiology of Hearing

All agreed that studies of listeners' preferences should be extended, but that the results should be analysed with due caution to avoid drawing false conclusions. Much remained to be learned about the physiology of hearing and the importance or otherwise of phase distortion. The difficulty was to measure the true phase relationships of the sound at the observer's ear, and experiments which were based on observations of the input waveform to the loudspeaker were of little value, without detailed knowledge of the transient response of the diaphragm and its effect on the acoustic output. Clear thinking was necessary before making generalizations, and comparisons of aural quality involving changes in the make-up of complex waveforms from similar spectral components were invalidated if there were redistribution of energy with time. An interesting case was cited of a series of pulses of random sign and amplitude, equally spaced in time, which on analysis showed a continuous spectrum like that of random noise. The aural effect, however, bore no resemblance to the characteristic hiss of random fluctuations.

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AMATEUR RADIO SHOW

New V.H.F. Equipment at the R.S.G.B. Exhibition

CONSIDERING that for the past three months amateur radio circles have buzzed with discussions on 2-metre operation, it was a foregone conclusion that V.H.F. would be the dominant note at the 1948 Amateur Show organized by the Radio Society of Great Britain. Despite the comparatively short time that has elapsed since the 145-Mc/s band was opened to amateurs all the radio manufacturers catering for this market had something of interest to show.

A complete new range of miniature variable condensers on 1⅜in square ceramic plates and with heavily silver plated metal parts was shown by Stratton. Included was an 8+8pF butterfly type with wide-spaced vanes as well as several split-stator models with staggered sections of from 15 to 40pF. The first-mentioned condenser is used in a new 145-Mc/s tuning unit consisting of an adjustable hairpin coil and coupling loop.

A well-finished four-element beam array for 2 metres, with a folded dipole radiator matching to a 72 ohm co-axial feeder, exemplified the compactness of high-gain aerial systems for these frequencies. Made of enamelled brass tubing it costs £6 5s complete.

An interesting example of ingenuity was the 3-element beam shown by G.E.C. and made entirely of standard light-alloy electric conduit and die-cast fittings. All parts screw together and only a hacksaw is needed to cut the rod elements to the required length. Tubing screwed at one end and up to 10 feet in length is readily obtainable.

Several V.H.F. transmitters exemplifying the best of modern miniaturisation technique were seen among the exhibits on the Tele-Radio stand. Although capable of quite a large power output, the sets are extraordinarily compact and serve as excellent examples of the advantages attendant on frequency modulation which is the system favoured. Narrow or broad band systems are applicable.

Among their receiving equipment was a neat converter for 2, 5 10 and 11 metres using plug-in coils, miniature valves and parts, and having a built-in A.C. power supply. It costs £21.

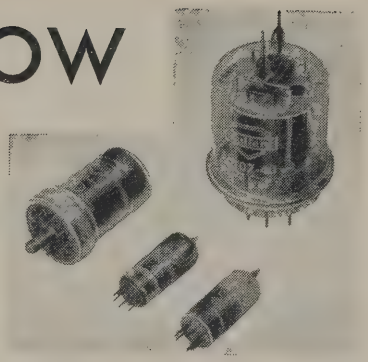
A few new valves for the very high frequencies are now becoming available to amateurs and several are in course of development, according to the prototypes seen on Mullard's stand. Their double R.F. power pentode is now known as the QQV07-40. It is an improved version of the American 829B, and fits the same valveholder. Some new miniatures on the B7G base were also seen, notably the EL91 pentode suitable for early stages in a transmitter, the EC91 grounded grid triode for R.F. amplification at E.H.F., and a double triode, the ECC91.

For final amplifiers in low-power V.H.F. transmitters, G.E.C. has now available an improved version of the TT15 double R.F. power tetrode. It can be used effectively to 200 Mc/s and at 300 volts on the anodes in a push-pull circuit gives 18 watts R.F. output for 90mA consumption. A feature of the valve is that the two electrode assemblies are virtually separate and can be used independently if required. An application of this kind was demonstrated in a 145-Mc/s transmitter.

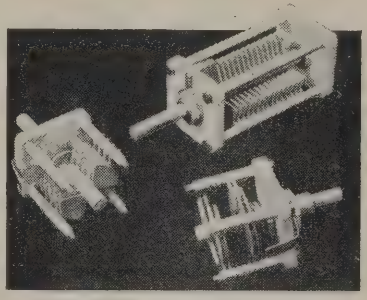
Other Osram valves of interest to the amateur include the DET19 (Re34 equivalent) a new high slope R.F. receiving pentode, the Z77 on a B7G base, the B65 double triode (6SN7 equivalent), and a range of A.F. power valves for modulators.

Some transmitting valves were shown by E.M.I., while Ediswan had a comprehensive range of receiving valves, such as the Mazda 6F12 RF pentode on the B7G base. It is a close equivalent, electrically, to the SP61.

Although components dominated the Webb's Radio stand, several interesting pieces of apparatus were also shown. For example, there was a 145-Mc/s transmitter, a variable frequency oscillator of high stability and a useful radio globe divided into amateur call-sign zones. Of the components a mention might be made of some valveholders for the 829 type valve. One is a screened version with built-in bypass capacitors on all contacts except the control grids (anodes being on top of the valve) and the other is a ceramic plate

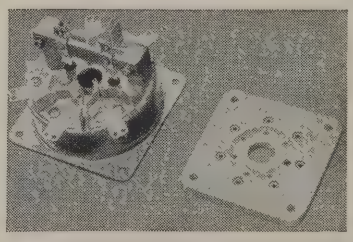


Mullard valves for V.H.F., the QV04-7, ECC91, EC91 and (at back) the QQV07-40.

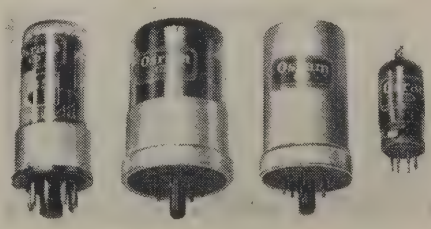


Eddystone ceramic Microdensers.

Panel handles made by Imhof.



Webb's Radio screened and open style valveholders for the 829 type valve.

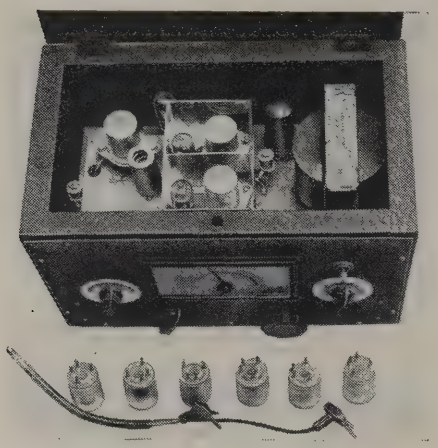


Four new Osram valves comprising the B65, TT15, W81 and Z77.

Amateur Radio Show—

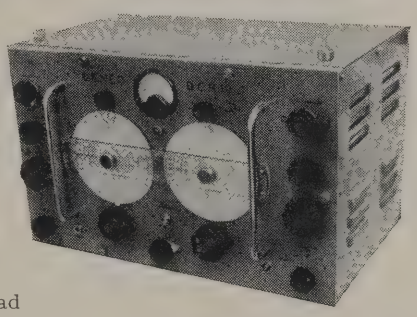
type. The former costs 17s 6d, the latter 5s 6d.

With so much new V.H.F. equipment, the more orthodox H.F. sets and parts were inclined to be overshadowed, but there was nevertheless a good selection in all classes. Components were shown by Denco, Odeon Radio, Radiocraft, Southern Radio and Electrical Supplies, Stratton, Tele-Radio and Webbs.



(Left) Tele-Radio V.H.F. converter with coils for the 2-, 5-, 6- and 11-metre bands.

(Below) Denco model DCR19 communications receiver.



A range of 25-watt C.W. transmitters for all amateur bands from 28 to 1.7 Mc/s with and without self-contained A.C. power supplies was shown by Radiocraft, while Odeon Radio had a 3-tier miniature rack transmitter measuring less than a foot high complete in every detail including plate current meter and giving 10 watts output on all bands.

Some fine examples of modern communications receivers were shown at this exhibition, but only an all-too-brief mention of them can be made here. The G.E.C. model BRT400 is a 14-valve receiver with six switched bands covering 150 kc/s to 33 Mc/s and it uses the latest miniature all-glass valves. It has two RF stages, mixer and oscillator, two I.F. amplifiers at 455 kc/s and a six-position selectivity switch for bandwidths of 500 c/s to 9 kc/s.

Another set of the same general category is the new E.M.I. communications receiver covering 550 kc/s to 30.5 Mc/s in six bands, and having a double 4-gang condenser with large and small capacitance sections. The five-stage selectivity switch makes available bandwidths of 100 c/s to 5 kc/s. An interesting feature of the design is that the A.G.C. line is accessible for connection to other receivers for diversity reception or for the injection of muting pulses from the keying circuit of a transmitter. It has a noise limiter and an "S" meter.

Considerable changes have been effected in the Eddystone 680 communications set, which now gives continuous coverage from 490 kc/s to 30.5 Mc/s in fine switched bands. Panel-controlled selectivity is obtained by mechanically varying the I.F. couplings, in addition to which a crystal filter is embodied for telegraphy reception. Thirteen of the latest all glass miniature valves are used with two R.F. and two I.F. amplifiers on 450 kc/s. Other features include noise limiter, "S" meter and bandspread.

A unique feature of the Denco DCR19 communications set is the use of a rotating coil turret fitted with dust-iron-cored coils wound on polystyrene formers. It is a 12-valve set, covers 175 kc/s to 30 Mc/s in six ranges with bandspread on the five amateur bands. It includes a 500-kc/s crystal calibrater, noise limiter, three I.F. stages at 1.6 Mc/s and a calibrated "S" meter. The price is under £50.

High selectivity combined with good second-channel rejection is obtained in the new Commander communications set made by Radiovision by using the double superhet principle. The first I.F. is 1.6 Mc/s and the second 100 kc/s; coverage is 1.7 to 31 Mc/s in five switched bands with electrical bandspread on all the amateur bands including 21 Mc/s. It employs eleven valves with voltage stabiliser for the oscillators, B.F.O. and "S" meter. The price is £48 10s.

A comprehensive selection of test equipment, multi-range meters and panel meters was shown by Sangamo Weston, Taylor Electrical and Automatic Coil Winder and Electrical Equipment, while transformers for power supplies, audio amplification and modulation were prominent on the stands of Oliver Pell Control (Varley) and Woden.

Among the wide range of fixed capacitors shown by T.C.C. were seen a number of new and improved models, a range that should interest makers of miniature equipments being the latest Metalite additions. A 0.01 μF 200-volt capacitor in an hermetically sealed aluminium tube measures $\frac{5}{8}$in long and $\frac{1}{4}$in in diameter. In this size capacitors range from 0.01 to 0.0002 μF.

A comprehensive range of metal cabinets with and without chassis, rack assemblies and a selection of chromium-plated panel handles were shown by Imhof. A typical receiver or transmitter cabinet, such as the type 1053A measuring 15$\frac{1}{4}$×9×8in overall and fitted with a 14×7×3in chassis and 4in panel handles costs £4 5s complete. Handles range in size from 4in to 8$\frac{3}{4}$in in eight different styles and cost from 3s to 7s each.

LIST OF EXHIBITORS

Alfred Imhof, Ltd., 112-116, New Oxford Street, London, W.C.1.
Automatic Coil Winder and Electrical Equipment Co., Ltd., Winder House, Douglas Street, London, S.W.1.
Denco (Clacton), Ltd., 355-359, Old Road, Clacton-on-Sea, Essex.
Edison Swan Electric Co., Ltd., 155, Charing Cross Road, London, W.C.2.
E.M.I. Sales and Service, Ltd., Wadsworth Road, Greenford, Middlesex.
General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2.
Mullard Electronic Products, Ltd., Century House, Shaftesbury Avenue, London, W.C.2.
Odeon Radio, 56, College Road, Harrow, Middlesex.
Oliver Pell Control, Ltd., Cambridge Row, Burrage Road, Woolwich, London, S.E.18.
Radiocraft, Ltd., 11, Church Road, Upper Norwood, London, S.E.19.
Radiovision (Leicester), Ltd., 58-60, Rutland Street, Leicester.
Sangamo Weston, Ltd., Great Cambridge Road, Enfield, Middlesex.
Salford Electrical Instruments, Ltd., Peel Works, Silk Street, Salford, Lancs.
Southern Radio and Electrical Supplies, 85, Fisherton Street, Salisbury, Wiltshire.
Stratton and Co., Ltd., Eddystone Works, Alvechurch Road, West Heath, Birmingham, 31.
Taylor Electrical Instruments, Ltd., 419-424, Montrose Avenue, Slough, Bucks.
Tele-Radio (1943), Ltd., 177a, Edgware Road, London, W.2.
Telegraph Condenser Co., Ltd., Wales Farm Road, North Acton, London, W.3.
Webb's Radio, 14, Soho Street, Oxford Street, London, W.1.
Woden Transformer Co., Ltd., Moxley Road, Bilston, Staffordshire.

BOOK REVIEWS

Ionospheric Radio Propagation. By the staff of the National Bureau of Standards. (Circular 426). Pp. 209; figs. 205. Supt. of Documents, U.S. Govt. Printing Office, Washington 25, D.C., U.S.A. Price $1; outside U.S.A. $1.33.

WRITTEN by a team of eleven experts, under the direction of the heads of the Central Radio Propagation Laboratory of America, this publication should, and does, contain a great deal of useful information about the ionosphere, and about radio propagation by its means. It is, in fact, the most comprehensive work on the practical use of ionospheric data so far published.

The book is divided into nine chapters, the first of which is merely an explanation of the scope and purpose of the book. Chapter II deals with the theory of wave propagation, and, considering that the book is intended to be of some use to those with only an elementary radio knowledge, this chapter might have been more lucid had the mathematical treatment been supplemented with more complete and somewhat less disjointed prose explanations of the physical processes involved. In Chapter III the details of the measurement, not only of ionospheric, but also of other atmospheric phenomena affecting radio transmission and reception, are well described, the principles of the equipment employed, as well as the techniques themselves, being briefly dealt with. Chapter IV deals with the main features of the ionospheric structure on a world-wide basis, so far as they are known. In Chapter V are described the very involved ionospheric variations with time, including those connected with the sunspot cycle. Chapter VI is perhaps the most important in the book, containing, as it does, not only a good explanation of the basis upon which are founded the methods for finding the M.U.F.s for any path at any time, but also full details of the operational procedures employed for this purpose, some of which, it is explained, have been established by other processes than theoretical ones. Chapters VII, VIII and IX deal with all those phenomena which affect the L.U.H.F. (lowest useful high frequency) or, alternatively, the L.R.R.P. (lowest required radiated power). These things include ionospheric absorption, fading, different forms of radio noise, radiated power, differences in aerial or set performance, etc., and finally, the calculation techniques employed. The whole subject is dealt with at considerable length, and some very useful graphs and diagrams are included.

Summing up, the book appears to be an almost indispensable publication for the ionospheric worker and for the specialist short-wave engineer, whilst it contains much that will be of use to the less specialized engineer and to the radio student. It is doubtful whether it will appeal to the amateur radio man, the techniques described being, in general, far too involved and cumbersome to suit his particular needs.

T. W. B.

Electronic Musical Instruments. By S. K. Lewer, B.Sc. Pp. 101, with 52 diagrams. Published from the offices of *Electronic Engineering*, 28, Essex Street, London, W.C.2. Price 3s 6d.

IN his introductory remarks the author defines an electronic musical instrument as one in which electrical oscillations are produced under the direct creative control of the performer. He excludes pipe organs with electrically operated actions, the amplification or reproduction of recorded sound and also synthetic sound tracks, but includes electric pianos and guitars as borderline cases.

The treatment covers a wide field and the author has obviously made a diligent search of the files of the Patent Office and of the world's technical literature for any information bearing on his subject. The fruits of this search are recorded in a bibliography running to seven pages. The facts are marshalled under headings determined by the principles of operation of the various instruments, and a chapter is devoted to an explanation of the method of classification. The emphasis throughout is on principles, and would-be amateur constructors of electronic organs will not find immediate answers to all their practical problems. Diagrams are chiefly schematic and circuit values are given only in a few isolated cases.

As an historical survey and a comparative analysis of principles and methods, this monograph is strongly recommended. F. L. D.

BOOKS RECEIVED

Electronic Engineering. Edited by E. Molloy. A general survey of applications of electronic methods to research and industry. Subjects covered include C.R. tubes, thyratrons light-sensitive cells, radio-frequency heating, etc. Pp. 108, with many diagrams and illustrations. George Newnes, Southampton Street, London, W.C.2. Price 5s.

Dictionary of Photography. 17th edition, revised by A. L. M. Sowerby, Editor of *Amateur Photographer*. A reference book for amateur and professional photographers dealing with all aspects of modern practice. Pp. 705; 67 illustrations. Fountain Press, 46, Chancery Lane, London, W.C.2. Price 15s.

40 Abaques de Radio.—By A. de Gouvernain. A collection of abacs for making design calculations graphically, each on a loose sheet card, with a 72-page book describing the method of use (in French). Société des Editions Radio, 9, Rue Jacob, Paris 6. Price 1,000 francs.

The following volumes in the Radiation Laboratory Series (Massachusetts Institute of Technology, U.S.A.) are written by a number of authors. They are published in this country by McGraw-Hill Publishing Company, Ltd., Aldwych House, London, W.C.2. All are fully illustrated. Prices given are those applying in U.K.

Microwave Transmission Circuits. Edited by George L. Ragan. A comprehensive treatise on the theory and practice of the transmission of microwave power along coaxial cables and waveguides and in their ancillary components, such as motional joints, impedance transformers, filters and power dividers. Pp. 725. 51s.

Loran.—Ed. J. A. Pierce, A. A. McKenzie and R. H. Woodward. Operation and design of the long-range navigational aid, mainly devoted to equipment now in operational use. Pp. 476. 36s.

Pulse Generators.—Ed. G. N. Glasoe and Jean V. Lebacqz. Theoretical and practical treatment of the generation of power pulses. Pp. 741. 54s.

Microwave Magnetrons.—Ed. George B. Collins. Theory, design and application of multi-cavity magnetrons for 1,000-24,000 Mc/s. Pp. 806. 54s.

Klystrons and Microwave Triodes.—Ed. D R. Hamilton, J. C. Knipp and J. B. H. Kuper. Low-power valves as local oscillators, signal generators and transmitters are discussed and there is a theoretical treatment of their use as mixers, amplifiers, oscillators and frequency multipliers. Theory and use of two-cavity and reflex klystrons is discussed. Pp. 533. 45s.

Principles of Microwave Circuits.—Ed. C. G. Montgomery, R. H. Dicke and E. M. Purcell. A fundamental treatment of guided electromagnetic waves. Pp. 486. 36s.

Microwave Duplexers.—Ed. L. D. Smullen and C. G. Montgomery. Methods of using a single aerial for both transmission and reception, as in radar. Pp. 437. 39s.

Cathode Ray Tube Displays.—Ed. T. Soller, M. A. Starr and G. E. Valley. Basic characteristics, principles of operation and methods of applications. Pp. 746. 60s.

—COMPACT

Kelvin-Hughes radar installation in a large trawler. An enlargement of the unit *in situ* is shown at the top of the opposite page.

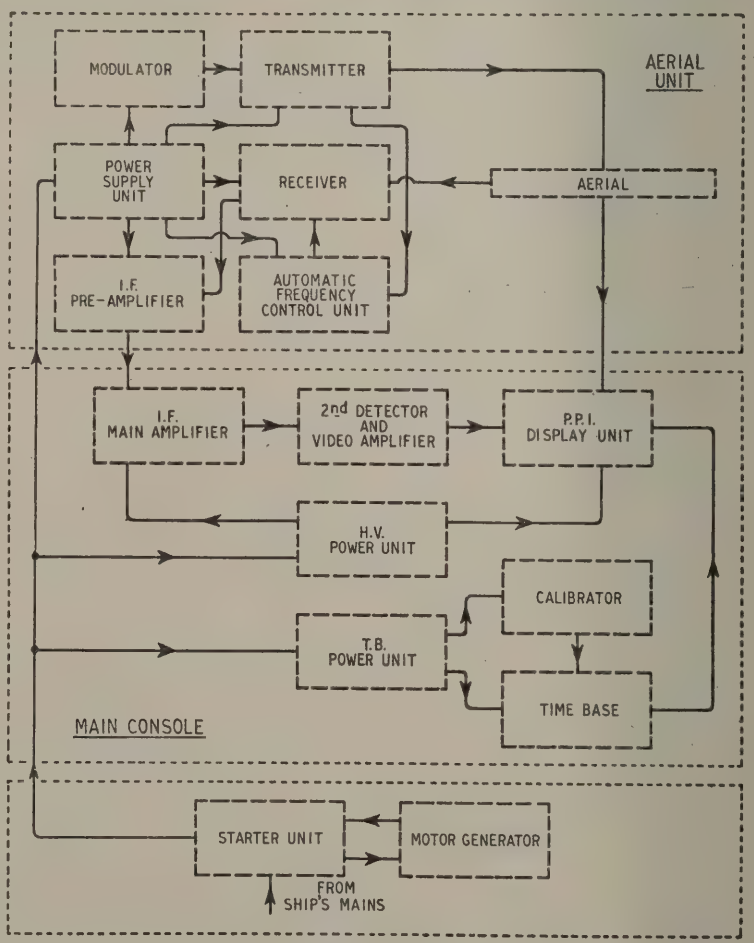
THERE is a current belief that navigational radar is a luxury for the big ships of the more opulent steamship companies. This may have been true in the early days after the war when the prototypes of mercantile radar were based on some of the larger Admiralty equipments, but now that designers have had an opportunity of exercising their ingenuity, the possibility is within reach that not only small coasters, but even fishing vessels may be able to avail themselves of this paying aid to navigation.

The latest Kelvin-Hughes equipment, which incidentally was one of the first commercial radar sets to obtain the Ministry of Transport's certificate of conformity with the Marine Radar Performance Specification, 1948, is a good example of the trend towards compactness and ease of installation. It has been fitted in a large trawler and has proved invaluable in locating fishing marker buoys in thick weather as well as for general navigation.

There are three main units: (1) the aerial, consisting of a rotating "cheese" reflector mounted directly on top of an "ironclad" case containing the transmitter, receiver and power supply units; (2) the display console, measuring 4ft 3in × 23½in × 19½in, with which are incorporated supervisory controls; and (3) a motor generator with automatic starter and control unit.

The virtue of combining the transmitter-receiver unit with the aerial scanner is that a short fixed waveguide, fully protected from moisture and mechanical damage, is possible. The transmitter-receiver unit is housed in a steel casing provided with three large hermetically-sealed doors. A thermostatically-controlled heater prevents icing in the aerial head.

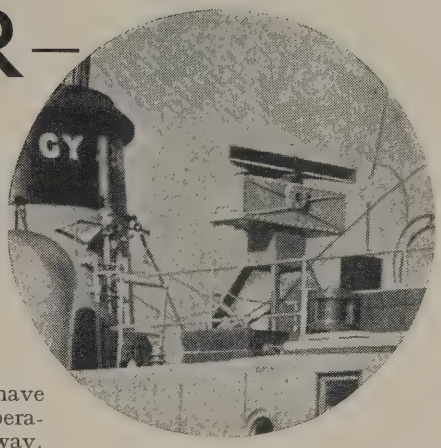
Components have been kept small by using a high-frequency (500 c/s) power supply, as is common practice in aircraft radar equipment. The magnetron heater transformer and pulse transformer are contained in an



Block schematic diagram of the Kelvin-Hughes marine radar equipment.

MARINE RADAR—

Some Details of the Latest Kelvin-Hughes Installation



oil-filled tank immediately below the magnetron valve. Peak power is 30 kW in a 0.2-μsec pulse having a repetition frequency of 1,000 per sec. The approved frequency band is 9434-9524 Mc/s.

A common T.R. waveguide switch, with gas cells, is employed and the frequency changer of the receiver comprises a CV720 klystron local oscillator and a mixer crystal. The intermediate frequency is 60 Mc/s with a bandwidth of 10 Mc/s; there is a preamplifier in the aerial unit and the main I.F. amplifier is in the display console.

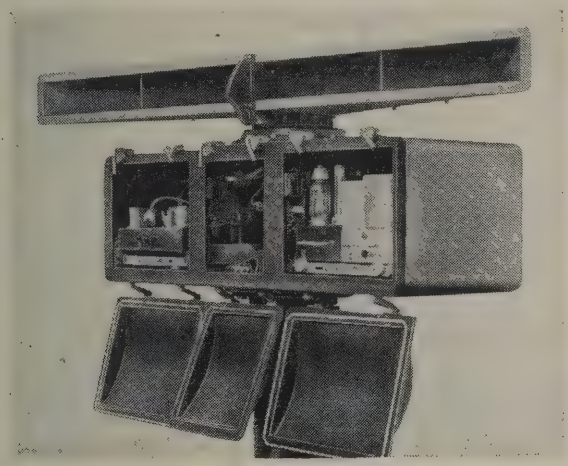
The magnetic deflector coils surrounding the neck of the 9in C.R. tube are rotated mechanically by servo motors coupled to the aerial scanner drive. The speed of rotation is 30 r.p.m.

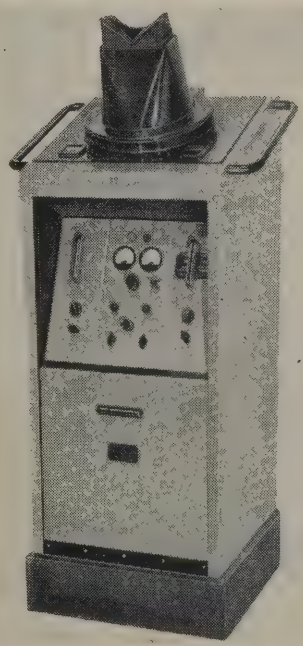
There are three range scales with maxima of 5, 9 and 27 miles, and concentric calibrator rings are provided at intervals of 1,000, 2,000 and 4,000yds, according to the range. In addition there is a continuously variable range-marker ring working in association with a calibrated dial on the top of the console. The manual control for the range marker is particularly neat and practical, and consists of a knurled edgewise wheel projecting slightly below the underside of the top panel for finger-tip control. This, and the substantial handholds on either side of the console indicate that the designers have had ample experience of operation in small vessels in a seaway.

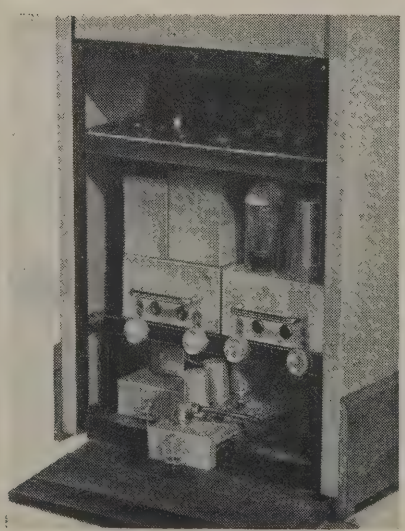
There is an electronic marker, indicating ship's head, and also a centre expansion control to facilitate the observation of bearings of nearby objects. An auxiliary gain control is available to reduce sea clutter near the origin, according to weather conditions. There is an illuminated bearing cursor which enables bearings to be taken with an accuracy of 1°.

The supervisory controls—stop-start switch, supply voltmeter, focus, brilliance, etc.—are mounted on a sloping panel in front of which is a sliding door—normally kept closed to prevent interference with the settings. All units are mounted on guides and can be readily withdrawn from the back for inspection. Fuses are readily accessible.

We have seen the equipment in operation and were impressed by the neatness and simplicity of the layout. The display was notable for the sharpness of focusing and the general clarity of the picture.







(Left) Aerial unit with inspection covers open. (Below) Display console with sliding front down, showing supervisory control panel and rear view of console, showing method of withdrawing units for inspection.

TELEVISION DISTRIBUTION

Details of a Communal System

By PAUL ADORIAN *(Central Rediffusion Services)*

(Adapted from a paper read before the International Television Convention, Zurich)

IN closely populated areas, and in particular in blocks of flats, the siting of television aerials presents many difficulties to individual householders.

It is usually possible to locate a good television aerial system at the top of a block of flats so that it gives reasonably good reception. The remaining problem, therefore, is to distribute the signal received by this aerial to the tenants in the block of flats concerned.

The same problem applies to groups of houses sharing a communal television aerial. The advantages of the latter case may not be fully appreciated but it has been established in practice that there is a considerable variation in signal to noise ratio at sites quite close to one another, depending on the relative position of the receiving aerial, transmitting aerial and sources of interference. Thus, while on one side of a road considerable interference may be caused by passing traffic, on the other side of the same road, by the use of a reflector on the receiving aerial, this interference can be reduced very considerably. It is obvious that it is a great advantage to bring up the quality of reception on both sides of the road to the same level.

Ultimately, one can visualize large groups of such local wire television distribution systems interconnected by a main distribution system.

The present paper is limited to the problem of local distribution, but reference is made to use of the wire distribution system for the simultaneous distribution of radio broadcast programmes.

Choice of System.—There are several methods by which television programmes can be distributed; we will consider the main systems.

Distribution at video frequences, say 0-5 Mc/s, might at first sight seem the most advantageous owing to the simplicity of the receiving sets. It also has the advantage that for very short distances the various H.T. and other power supplies could also be transmitted on cables as well as the audio-frequency sound programmes so that the viewer would have an extension loudspeaker for sound reproduction and a cathode-ray tube display unit for picture reproduction with little additional equipment and no direct local connection to the electric mains supply.

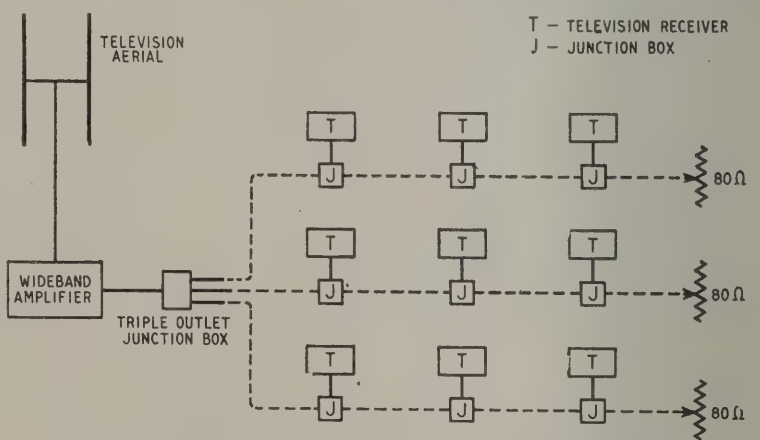


Fig. 1. Arrangement of a direct carrier distribution system.

After practical examination of this system, the conclusion was reached that the saving made in cost of receiving equipment would be counterbalanced by the cost of special cables and distribution equipment required. Further, it was thought, right from the beginning, that eventually, due to mass production, the price of television sets would come down to such a low figure that the technically simpler sets such as envisaged by this system but made in smaller quantities, could not be made at much lower prices.

A further technical difficulty that must be taken into account in this system is that at video frequencies careful correction of lines is necessary if serious distortion is to be avoided. It must be remembered that at video frequencies, the attenuation along wire lines of the low and high frequencies is very different, and such attenuation will vary considerably along the line. In addition, correction must be made for phase distortion. Thus, such systems are very critical as regards variation in load, which would entail expensive engineering operations.

Distribution at an intermediate-frequency carrier on which the modulation could be superimposed has also been considered. A carrier of the order of 10 Mc/s was considered with modulation of up to ±5 Mc/s.

This system has the advantage of simplifying the television receivers by eliminating the radio frequency part of the equipment. However, it introduces more complicated sending-end equipment, and on balance could only be justified with very large systems.

Direct Carrier Distribution.—The third system which was considered consists of receiving, amplifying and distributing over wire lines the complete carrier and sidebands of the transmitted programmes. So far as the B.B.C. television service is concerned, this involves the transmission of a frequency band of from 41 to 49 Mc/s.

The advantages of this system are numerous. First, subscribers connected to the system can utilize any television receiver suitable

for the London transmission. Next, the distribution equipment is extremely simple and, what is considered most important, the system is not particularly critical as regards load variation and, once a television supply feeder is constructed and laid out to the plan described below, there is no further engineering involved except normal maintenance.

A disadvantage of this system may be that as a relatively high carrier frequency is used, a more expensive cable may have to be employed than for a system distributing at lower frequencies, but in practice this difference in cost if almost negligible in relation to the total cost of the installed system.

It has been found in practice that this type of distribution system can be operated with line lengths up to 500 metres.

A further advantage of this system is that as the frequencies below 40 Mc/s are not used for main television distribution, the same concentric cable can be used for providing aerial inputs to broadcast receivers and possibly, at a later date, when high television subscribed densities are obtained, a second television programme, if available, could be simultaneously transmitted on the system in accordance with the intermediate system referred to above.

Details of the System.—In view of the foregoing considerations this system was adopted and at the time of preparing this paper 57 systems have been installed, making television service available to 6,400 households, of which approximately 600 are subscribing to the system.

In view of the interest already shown, it is expected that this number will be considerably increased in future, and work is in hand for the installation of similar systems for several other groups. The system used as shown schematically in Fig. 1.

A conventional vertical dipole with reflector is used which is connected to a broad-band amplifier, and from this connection is made to up to three concentric cables through a matching arrangement. In the diagram the concentric distribution cables are shown in dotted lines.

It should be noted that, as explained later, the junction boxes include a loss pad which, near the sending end, introduces a 40-db loss between line and receiver, while the matching pads farther away from the sending end introduce a loss of 20-db between line and receiver.

The wide-band amplifier has four reactance-coupled stages, and gives approximately uniform gain of 55 db from 42 to 48 Mc/s. The response falls off symmetrically at each end and the response is about 6-db down at 41.5 Mc/s and 48.5 Mc/s respectively. The output voltage is of sufficiently high level so that when followed by a three-way matching pad connected to three 80-ohm lines, an input of 0.75 volt is available to each line. All the four amplifying valves are of the same type and a valve rectifier is used in the built-in A.C. mains power unit.

A concentric semi-air-spaced polythene-insulated cable with the following dimensions and characteristics is used for distribution:—

Overall diameter: 0.685 cm.
Inner conductor diameter: 0.091 cm.
Outer conductor diameter: 0.533 cm.
Loss per metre at 45 Mc/s: 0.062 db.
Loss per metre at 1 Mc/s: 0.009 db.
Characteristic impedance of cable: 75-80 ohms.

The system has been so designed that the input voltage to receivers at different positions along the lines is not less than 0.75 millivolt and not more than 7.5 millivolts.

The system is designed to supply under these conditions up to about 30 television receivers on each line spread over a length not longer than 480 metres.

Fig. 2 shows the performance of such a feeder, 480 metres in length with 32 television receivers connected, distributed uniformly along the feeder.

The top graph in this diagram shows the attenuation along such a feeder in a completely unloaded condition, but at the end the line is terminated with an 80-ohm resistance, which is always used. The middle graph shows the actual line voltage due to the attenuation caused by the connection of the television receivers, while the bottom graph shows the actual voltages as applied to the inputs of the television receivers along the line. It should be noted that the first 16 receivers are connected through 40-db pads, while the second 16 receivers are connected through 20-db pads. (As the receiver input impedances are about 75-80 ohms each, in the case of 40-db pads a 7,500-ohm series resistance is used, while in the case of 20-db pads a 750-ohm series resistance is used at the appropriate junction boxes.)

Increasing the Scope.—While the system described above is able to supply over 90 television sets on three lines, a further extension of the system has been developed by means of which it is possible to feed up to 15 lines and a total of about 450 subscribers.

In this arrangement the output of the wide-band television amplifier is connected to the inputs of up to three output units. Five

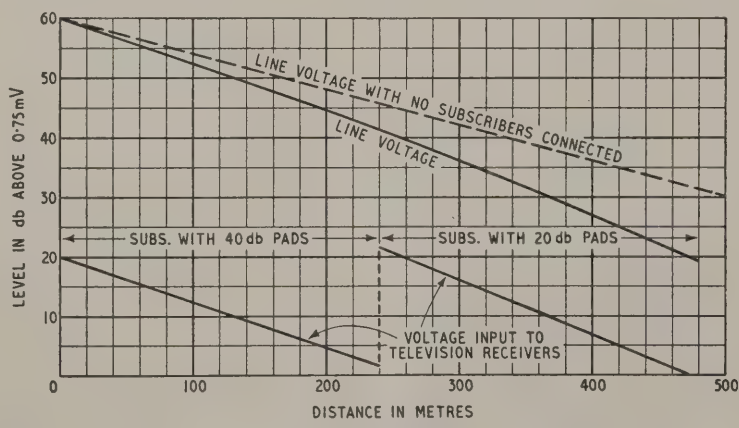


Fig. 2. Performance of the system shown in Fig. 1, giving line distribution characteristics (one subscriber per 15 metres).

Television Distribution—
similar cathode followers are incorporated in each output unit, and each of these one-stage "buffers" can feed one line. Thus, 15 lines can be supplied. Fig. 3 shows the general arrangement.

A further extension of the system is possible by extending the length of the feeders by the introduction of repeater amplifiers, but up to the time of writing this paper, this has not yet been necessary in practice.

Television and Broadcast.—The system has been further developed for use as a combined television and broadcast aerial system, in its present form for the distribution of medium- and long-wave broadcast inputs and the television distribution described above. The general sending-end arrangement used is shown on Fig. 4 and is self-explanatory.

Where such arrangements are in use, it is usual to connect the aerial terminal of the subscriber's broadcast receiver to the concentric cable through a 750-ohm resistance and connect a small capacitor which presents high impedance to the medium- and long-wave broadcast signals, in series with the subscriber's television set aerial terminal.

It will be noted that no wide band amplifier is shown in conjunction with the broadcast aerial as this is not necessary at sites where strong broadcast signals are available, but such an amplifier could be included between the aerial and the low-pass filter if necessary.

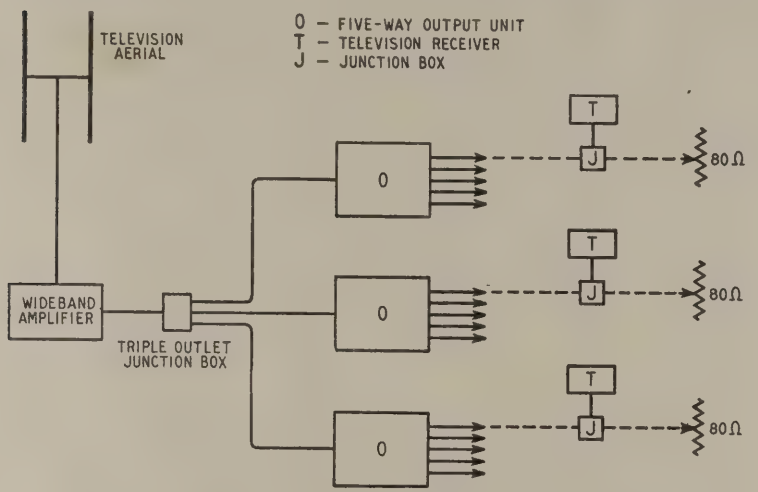


Fig. 3. Extending the system to feed more receivers.

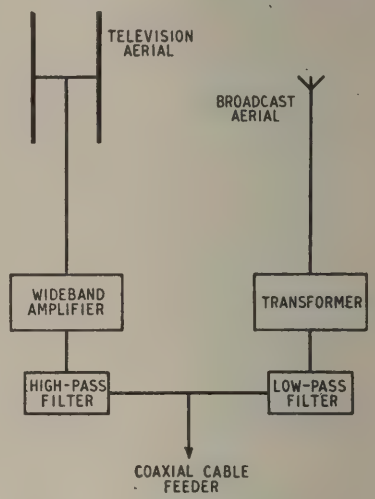


Fig. 4. Communal distribution system for both television and sound broadcasting.

Acknowledgment.—The author wishes to thank H. J. Barton Chapple and R. I. Kinross, of London Rediffusion Service, who have been mainly responsible for this development and who have assisted in the preparation of this paper.

NEWS FROM THE CLUBS

Basingstoke.—Two series of lectures—one on A.C. theory and the other on television theory and practice—are being given to members of the Basingstoke and District Amateur Radio Society during this session. The lectures will be held on alternate Tuesdays at 7.45 at the British Workmen's Assembly Rooms, Potters Lane, Basingstoke. Sec.: L. S. Adams, 16, Bramblys Drive, Basingstoke, Hants.

Chatham.—Two thousand people visited the exhibition organized by the Medway Amateur Receiving and Transmitting Society in Rochester from November 24th to 27th. Among the manufacturers exhibiting were:—Mullard, Decca, Denco, S.T.C., Philco and Automatic Coil Winder Co. On the Admiralty stand was included W.T. equipment, radar gear, and the Decca Navigator. Meetings of the society are held on Mondays at 7.30 at the Co-operative Employers' Welfare Club, 207, Luton Road, Chatham. Sec.: H. Howell, G5FN, 39, Broadway, Gillingham, Kent.

Derby.—The annual general meeting of the Derby and District Amateur Radio Society will be held on January 5th at 7.30 in the Club Room, 67B, London Road, Derby. The society, which now has its own transmitter licensed under the call G3ERD, meets on alternate Wednesdays. Sec.: F. C. Ward, G2CVV, 5, Uplands Avenue, Littleover, Derby.

Edinburgh.—The general monthly meeting of the Lothians Radio Society will be held in the Chamber of Commerce Rooms, 25, Charolette Square, Edinburgh, on January 27th at 7.30. Meetings are held on the last Thursday in each month. Sec.: I. Mackenzie, 47, Easter Drylaw Drive, Edinburgh, 4.

Nottingham.—New premises have been secured by the Nottingham Short-Wave Club, and weekly meetings are now held on Mondays at 7.15 at the Old Boys' Club, Middle Street, Beeston, Notts. The club's transmitter, G3EKW, was officially opened on December 6th by F. R. Sharp, Radio Editor of the *Nottingham Evening Post*. It is situated at Chilwell and at present radiates on 1.7Mc/s. Sec.: N. W. Adcock, "Bryn-gates," Harlaxton Drive, Long Eaton, Notts.

Oldham.—Meetings of the Oldham Radio Society are held on alternate Wednesdays at 7.30 at the Civic Centre, Clegg Street, Oldham. The next meeting is on Dec. 29th. Sec.: E. Hulme, G3BQT, 20, Parkway, Chadderton, Lancs.

Romford.—The late secretary of the Romford and District Amateur Radio Society, R. C. E. Beardow, has emigrated to Canada and has taken with him his 10-metre transmitter (G3FT). The new secretary of the club, which meets on Tuesdays at 8.0 at the Y.M.C.A., Western Road, Romford, is D. Coppendale, G3BNI, 9, Morden Road, Chadwell Heath, Essex.

VERSATILE POWER SUPPLY

Wide Range Voltage Control with Simplified Switching

By K. F. BUTCHER

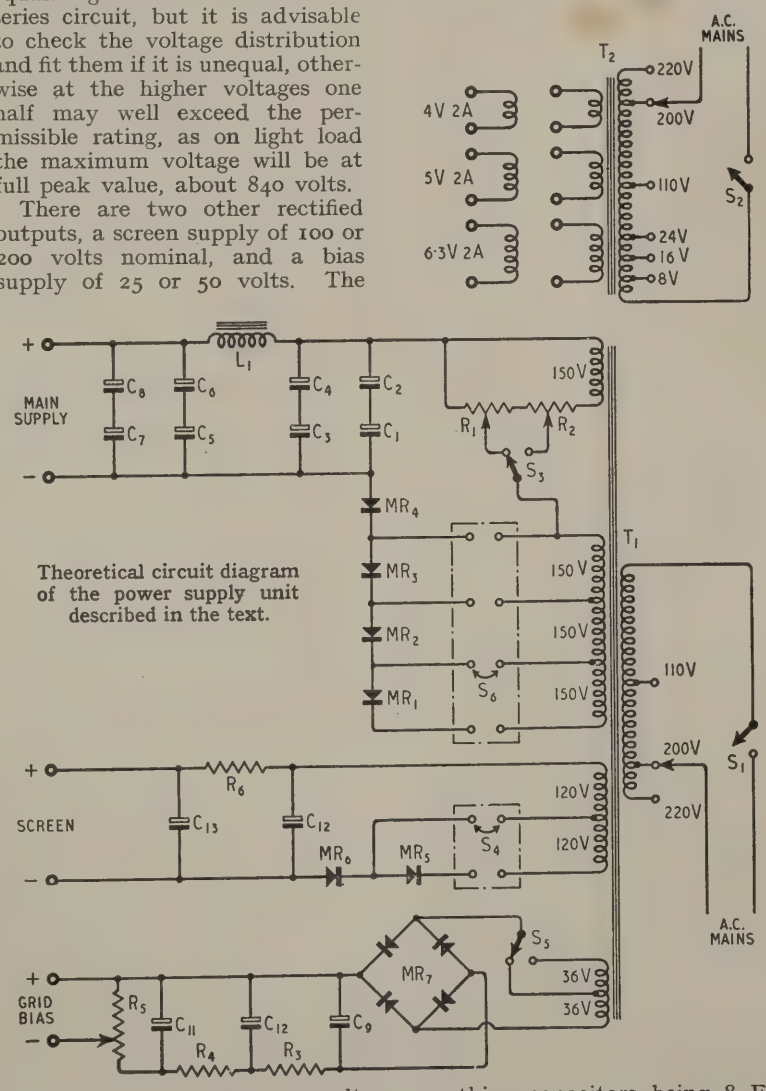
IN experimental work there often arises the need of a power supply giving a wide range of voltages at various currents and which is easily and quickly set to any desired value. The unit described here covers most requirements of light current work and has proved well worth the time expended in its construction.

It will be seen from the circuit diagram that the main supply is in three steps of 150 volts with four half-wave selenium rectifiers giving 120 mA maximum. This is not the most efficient arrangement, but it keeps the switching simple. There is a fourth 150-volt winding feeding a potentiometer comprising R_1 and R_2 which is connected in series with the other windings. This is a more convenient method of regulating the voltage than the usual series resistance, or potentiometer across the output. Also the potentiometer current is supplied by the transformer and not by the rectifiers. This is rather wasteful at the lower voltages but the convenience is well worth it. Two potentiometers were used in series as there did not appear to be a single one listed of the correct value and wattage in a reasonable physical size. This necessitated S_3 to switch the sliders for each half as required. In use this was found to be an advantage rather than otherwise, inasmuch that the scale is approximately 600 degrees for 150 volts variation, which is 4 degrees movement per volt, and it was found quite easy to adjust the value to within 0.25 volt. This gives a smoothness of control which is a pleasure to use.

A 32-μF reservoir capacitor was specified by the makers for the rectifiers, and it was considered desirable to allow for a working voltage of 1,000. These are not listed in electrolytic types so a series-parallel combination of four standard T.C.C. 500-volt working capacitors is used. It was not necessary in this case to put equalizing resistances across the series circuit, but it is advisable to check the voltage distribution and fit them if it is unequal, otherwise at the higher voltages one half may well exceed the permissible rating, as on light load the maximum voltage will be at full peak value, about 840 volts.

There are two other rectified outputs, a screen supply of 100 or 200 volts nominal, and a bias supply of 25 or 50 volts. The screen supply will give 200 volts at 30 mA, or proportionately higher at a lower current. As most screen currents are reasonably constant for a given voltage, and usually amount to only a few milliamps, resistance smoothing has been used, but a choke and capacitor can be added externally with the series resistance if needed. The current output of 30 mA allows for the drain of a high-resistance potentiometer if a variable voltage is required.

The bias supply has a bridge-type rectifier and double resistance smoothing, the reservoir and first smoothing capacitors being 8μF, but the final one is 32μF. The output is across a 20,000-ohm potentiometer R_5, and the current



Theoretical circuit diagram of the power supply unit described in the text.

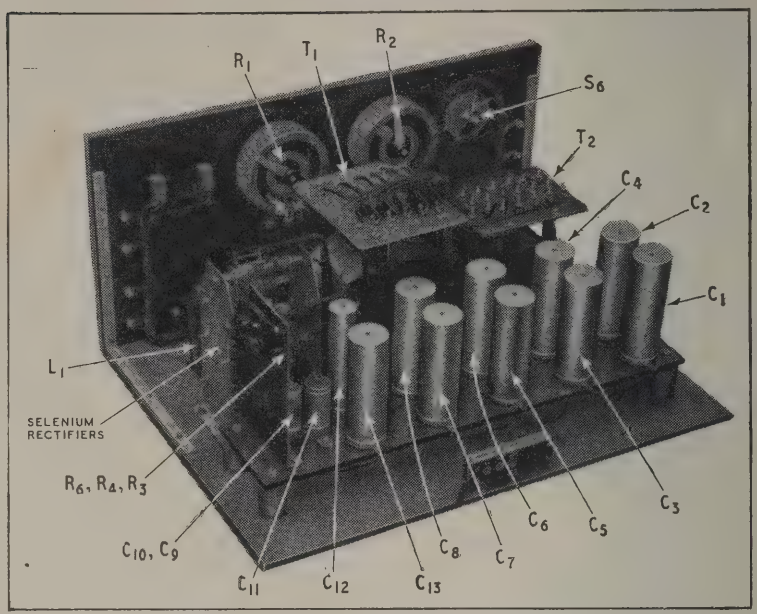
Versatile Power Supply—

is limited to 1 mA. This will allow for any reasonable grid current encountered and has been found adequate. It was felt that at low voltages a wider scale would be advantageous so the input to the rectifier is in two halves which doubles the scale of the potentiometer.

It is apparent that with the addition of a filament supply we have a complete unit that will supply a single valve hook-up, amplifier or radio chassis. Also it is possible to take a complete family of curves of most valves in general use. Consequently a heater transformer is incorporated having double windings of 4, 5, and 6.3 volts at 2 A each and with appropriate terminals brought out to the panel. Three eight-volt tappings on the primary enables the correct voltage to be obtained when using one valve or several.

When taking valve curves it is advisable to put a bleeder resistance across the main output when on low currents as there is a visible delay of the potentiometer setting due to the charge on the capacitors.

In conclusion, any stampings available will do for the two transformers, in this case 144 pairs of I.S.C.O. 435A (Stalloy 35A) were used for T_1, which worked out at 1.85 turns per volt, and 80 pairs of I.S.C.O. 460A (Stalloy 33A) for T_2 at 4 turns per volt. T_1 requires three windings of 150 volts at 0.3 A, one of 150 volts at 0.6 A, two of 120 volts at 0.07 A, and one of 36 + 36 volts at 0.01 A. T_2 requires six 2-A windings for the three heater voltages.



This photograph shows the form of construction adopted and the position of the main components.

COMPONENT VALUES

C_1–C_8, C_{13}	32μF 500 V electrolytic
C_9, C_{10} ..	8μF 100 V ,,
C_{11} ..	32μF 100 V ,,
C_{12} ..	16μF 500 V ,,
R_1, R_2 ..	225Ω, 0.66 A toroidal-wound potentiometer (Berco Type 100)
R_3, R_4, R_6	1 kΩ, 2-watt (carbon)
R_5 ..	20kΩ, 2-watt wire-wound potentiometer
S_1, S_2 ..	S.P.S.T. switch
S_3, S_4, S_5	S.P.D.T. ,,
MR_1–MR_4	Half-wave selenium rectifier (S.T.C. Type H35-14-IL)
MR_5, MR_6	Half-wave selenium rectifier (S.T.C. Type H18-12-IL)
MR_7 ..	Half-wave selenium rectifier (S.T.C. Type B18-4-IL)

MANUFACTURERS' LITERATURE

Descriptive leaflet of screws and small parts made by the Anglo-Swiss Screw Co., Trout Road, West Drayton, Middlesex.

Leaflet giving details of the Type NMS industrial noise measuring instrument made by A. E. Cawkell, 7, Victory Arcade, The Broadway, Southall, Middlesex.

List No. 5 of disposals radio and electronic equipment from Clydesdale Supply Co., 2, Bridge Street, Glasgow, C.5.

Leaflets describing Type 1210A frequency meter and photoelectric pick-up unit, and Type 1250A dynamic balancing machine, from Dawe Instruments, 130, Uxbridge Road, Hanwell, London, W.7.

Folder giving ratings and operating data on the Mazda B8A range of valves, from the Edison Swan Electric Co., 155, Charing Cross Road, London, W.C.2.

Leaflets dealing with Type XE and Type H15 (heavy duty) relays, from Electro Methods, 112, Brent Street, London, N.W.4.

Data sheets of sound reproducing equipment made by Grampian Reproducers, The Hanworth Trading Estate, Feltham, Middlesex.

Illustrated leaflet describing electronic audio-frequency mixer units made by Hifi, Ltd., Lye, Worcs.

Catalogue C262 of replacement capacitors made by A. H. Hunt, Bendon Valley, Garratt Lane, London, S.W.18. Available to members of the distributive and service trades.

Leaflet describing the Pennine Ranger Model E54/2 superheterodyne receiver made by Pennine Amplifiers, Southgate, Elland, Yorks.

Illustrated folder giving details of television receivers, from Ultra Electric, 62, Buckingham Gate, London, S.W.1.

An illustrated booklet isued to the trade by Whiteley Electrical Radio, Mansfield, Notts, gives details of the "Long Arm" system of remote control, production of which has now been resumed.

CRYSTAL CALIBRATION SERVICE

Measurements of the resonant frequency of quartz crystals of all types with an accuracy of at least 5 parts in a million are undertaken by Salford Electrical Instruments, Q.C. Department, Birch Mill, Birch in Hopwood, Heywood, Lancs. A fee of 5s (which includes return registered postage) should accompany each crystal, which should be sent by registered post and marked "Frequency Calibration Service." The full name and postal address to which the units are to be returned should, of course, be included.

ELECTRONIC CIRCUITRY

Selections from a Designer's Notebook

By J. McG. SOWERBY (*Cinema Television Ltd.*)

Interval Timers

THERE are now several interval timers available commercially, intended for measuring times from one millisecond to one second or so. Most of these operate much as shown in Fig. 1. A constant current circuit (e.g., a pentode) is adjusted to pass a current i; this current passes through the switch S which is closed for the duration of the time interval to be measured and charges the condenser C. The potential difference, E, appearing across C is measured by a valve voltmeter V. The equation for E is

$$E = \frac{it}{C}$$ where t is the time for which S is closed.

If now a resistance R is placed in parallel with C, and S closed, the p.d. across it will be

$$E_0 = iR \quad .. \quad .. \quad .. \quad (1)$$

We may now adjust i until E_0 produces full scale reading on the valve voltmeter. In the absence

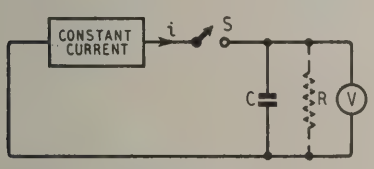


Fig. 1. Schematic circuit of interval timer.

of R, full scale will be produced by S remaining closed for a time given by

$$t_0 = \frac{E_0 C}{i} \quad .. \quad .. \quad .. \quad (2)$$

Now substituting the value for i from (1) in (2) we obtain

$$t_0 = RC$$

Thus the instrument is calibrated in terms of R and C exclusively, and provided good drift-free components are chosen for R and C the calibration should remain unchanged over long periods of time. Various ranges may be obtained by varying i, C or E_0 in known steps, yielding full scale readings of about 1 millisecond to 1 second.

For much longer times wither C becomes uneconomically large, or i becomes awkwardly small. Much shorter times can be measured by means of more complicated circuits but these will not be considered here.

A typical circuit used for this work is shown in Fig. 2.

Suppose S_1 to be open and that E_1 is sufficient to make V_1 conducting. The resistances are chosen so that V_1 and V_2 form a trigger circuit, and V_2 is consequently cut off. If S_2 is now

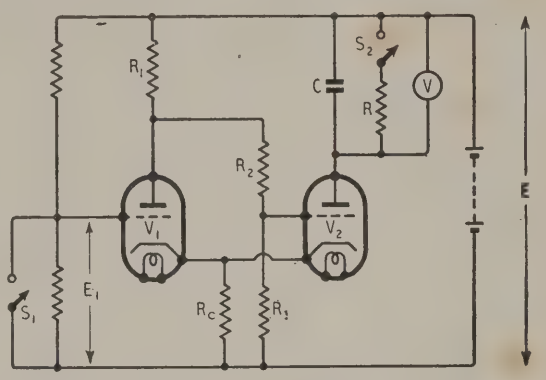


Fig. 2. Combined trigger and charging circuit.

closed temporarily any remanent charge on C is removed, and the valve voltmeter V indicates zero. S_1 is now closed for the duration of the interval to be measured, V_1 cuts off and V_2 conducts, behaving much as a cathode follower passing a current of

$$i = \frac{ER_3}{(R_1 + R_2 + R_3)\,R_c}$$ (approximately).

This current flows into the condenser until S_1 is opened and the trigger reverts to its rest state of V_1 conducting and V_2 cut-off. The voltmeter is calibrated in terms of time with the aid of R as described above. The current may be adjusted by variation of R_c.

The input circuits are not, of course, limited as that shown in Fig. 2, and may be arranged in a variety of ways so that measurements of the time between two pulses, the duration of a pulse or light flash, etc., may be made.

The main design difficulty of this type of device is the elimination of drift, due to charge accumulating on, or being dissipated from C, both before and after a measurement is made. This drift appears as a slow change of voltmeter reading. Taking Fig. 2 as a sample of the numerous circuits available, drift can arise from one or more of any of the following causes :—

(1) Leakage in C. (2) Leakage in V. (3) Leakage across the valve holder of V_2. (4) Leakage across the insulators of the electrode assembly of V_2. (5) Failure of V_2 to cut off completely. (6) Emission of photo-electrons by the anode of V_2 (7) Leakage across S_2. This seems a formidable array of difficulties, but all can be overcome with care, and drifts in good commercial instruments seldom exceed 5 per cent of full scale on the indicating meter per minute.

Transformerless Phase Shifter

THE phase shifting device of Fig. 3 is well known; it is described for instance in Puckle's "Time Bases" (p. 190). Readers of that useful work will remember that if the reactance of the condenser is made about one tenth of the maximum value of R a very useful phase shift from about 20° to about 160° can be

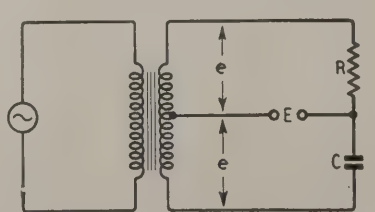


Fig. 3. A well-known phase-shifter circuit.

Electronic Circuitry—

obtained, and that if no load is imposed on the output terminals, the output voltage $E = 2e$.

When it is desired to phase shift a wide band of frequencies (for which a number of condensers of varying capacities will be needed, chosen in rotation by a switch) the design of the transformer presents difficulties. It is not always realised that an excellent alternative* is the circuit shown in Fig. 4. Here

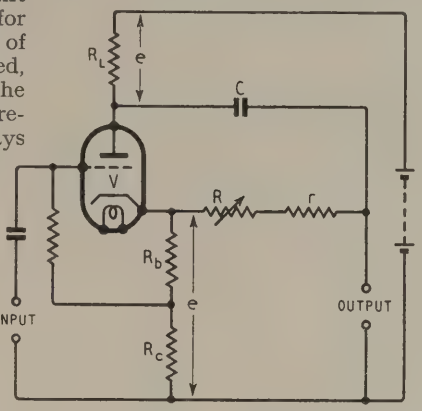


Fig. 4. Transformerless phase shifter. Typical values: V = EC91; $R_L = R_C = 2.2\,k\Omega$; $R_b = 100\,\Omega$; H.T. supply 250 V, 10 mA. At input frequency about 100 kc/s, C = 50 pF. R = 50 kΩ (carbon), $r = 8.2\,k\Omega$.

the valve is arranged as a "concertina" phase splitter and $R_L = (R_C + R_b)$. The design is quite normal and straightforward and familiar to readers. Two signal voltages e are obtained, and their "centre-tap" is virtually the earth line. Consequently the valve replaces the transformer of Fig. 3, and the R.C. phase shifting network is applied between anode and cathode as shown. The overall gain is about 1.8 for usual designs. Care must be taken to make the impedance of the R.C. circuit large compared with R_L, and so an additional resistance r is used to prevent the resistive arm being reduced to zero resistance.

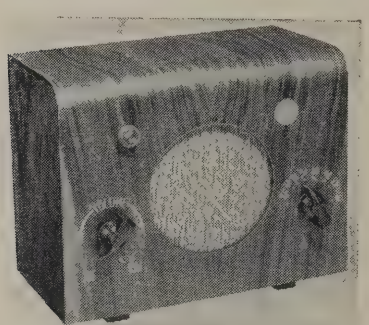
This circuit finds many uses, one of which is in the generation of circular and elliptical time bases for cathode ray oscillography.

The writer has used this circuit at 1 Mc/s quite successfully to obtain a 45° shift, employing a miniature high-slope triode and low values of R_L and R_C; but this is probably near the limit, because as the frequency increases the loading on R_L increases and the available range of phase shift is reduced.

* Dome, R. B., *Electronics*, Dec. 1947, p. 111.

NEW DOMESTIC RECEIVERS

A CONSOLE version of the A52 bandspread receiver for A.C. mains reviewed in our issue of March, 1948, has been produced by E. K. Cole, Southend-on-Sea. It is known as the C87 and costs £40 19s, including tax. A special export version of the Ekco "Consort" A.C./D.C. transportable has also been introduced. With the type number U83, this model has



General Electrical Radio "Mighty Midget" A.C./D.C. receiver.

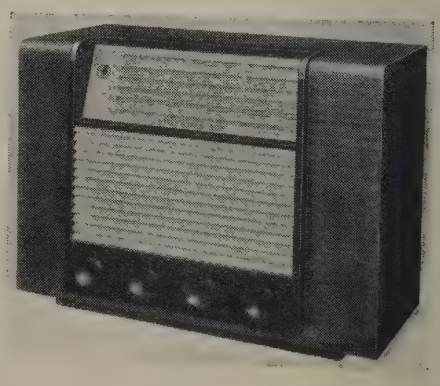
three waveranges covering 1,500-560 kc/s, 8-3 Mc/s, and 22-7.5 Mc/s. The "Mighty Midget" A.C./D.C. receiver made by General Electric Radio, 92, Charlotte Street, London, W.1, sells for the unusually low price of £6 19s 6d, including tax. It is a straight set with 12K7 R.F. amplifier, 12J7 detector, 35L6 output valve, 35Z4 rectifier (or metal rectifier) and 1669 barretter regulator. The single waverange covers 200-550 metres. The walnut veneered cabinet measures 8½in × 7in × 4½in and houses a frame aerial in addition to the 5in moving coil loudspeaker.

Two new table models for A.C. mains have been announced by Pye, Ltd., Radio Works, Cambridge. The Model 19A is a superhet. (3 valves plus rectifier) with the following waveranges: 16m, 31m and 49m (bandspread), 200-550m and 1,000-2,000m. In the Model 19D (4 valves plus rectifier) there are additional bandspread ranges centred on 13m, 19m and 25m and a wider range from 38 to 110m. The Model 19A has a 6½in loudspeaker, a five-position tone control and costs £21 13s 4d, while the 19D with eight-position tone control and 8in loudspeaker costs £26 15s 4d, including tax.

The circuit of the new Ultra table Model T457 for A.C. mains comprises a frequency changer, I.F. amplifier, detector and phase-splitter, and push-pull output valves, delivering 6 watts to an elliptical loudspeaker. The six waveranges cover 10.7-18m, 18.7-20m, 24.2-26.3m, 30-51.8m, 200-550m and 1,000-2,000m with bandspreading on the ranges centred on 19 and 25m. The price is £37 14s 4d and the makers are Ultra Electric, Western Avenue, London, W.3.

In the Invicta Model T102 television set the T.R.F. vision receiver is fitted with an interference limiter, and the time base circuit has a positive interlace filter with grid blocking line and frame scan oscillators. The picture size is 7¾in × 6in and the price is £55 5s 9d, including tax. A console version (Model T103) is available at £66 17s 3d; the makers are Invicta Radio, Parkhurst Road, London, N.7.

Brief details have also been received of a new television receiver (Model MTS389) made by Mullard Electronic Products, Century House, Shaftesbury Avenue, London, W.C.2. It is housed in a table model cabinet 25½in × 17in × 13in and employs a 9in tube with black and white screen. The price is £61 14s 5d, including tax.



An elliptical loudspeaker is fed from a 6-watt push-pull output in the Ultra Model T457 receiver.

THE "BELLING LEE" PAGE

Providing technical information, service and advice in relation to our products and the suppression of electrical interference

The Wireless Telegraphy Bill

By the time this is published, it is expected that the Bill will have passed the committee stage and many "Wireless World" readers will have been asked what it is all about. There really has been a lot of fuss over very little. Anyone who has a wireless licence has already given permission for the representatives of the Post Master General to enter at reasonable times. There is a similar clause in the contract regarding the supply of gas and electricity.

Among the most prevalent causes of electrical interference are thermostats in electric bed-warmers (pads, blankets and imitation hot water bottles).

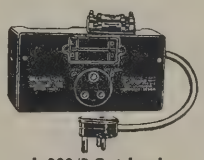
Advice to the Culprit

Many domestic appliances can be very efficiently dealt with by fitting flex lead suppressors*1 preferably close to the appliance. Every few inches of lead count. These suppressors will prove adequate, except in particularly fierce cases of earthed (3 core flex) portable appliances used in blocks of flats where neighbours, with radio sets in close proximity, might still hear some residual interference unless they have taken special precautions with their aerials. More thorough suppression requires the filter component fitted inside the appliance. If in doubt, go to your local radio dealer or write to "Belling-Lee."

Flex lead suppressor L.301 (3 core)

Advice to the Sufferer

If a person is being troubled by outside interference, the first question should be: "What do you do about an aerial?" There must be tens of thousands who do nothing about it, or at best dangle a bit of wire about the room. Some kind of outside aerial is necessary before a listener can expect sympathetic help from official channels. The simplest remedy is a "Winrod" window mounting aerial*2 This is not an anti-interference aerial, but in most cases will greatly improve reception.



L.300/3 Set lead suppressor

In circumstances where interference is very severe, or where exceptional quality is the aim of the listener, it will be necessary to erect a "Skyrod" vertical aerial*3 with "Eliminoise" transformers and a screened down lead. In cases where interference is reaching the receiver via the mains, i.e. mains borne, a set lead mains filter *4 will be necessary. This is fitted at the power plug supplying the receiver. It is a simple "plug-in" device.

Car Interference with Television

L.630

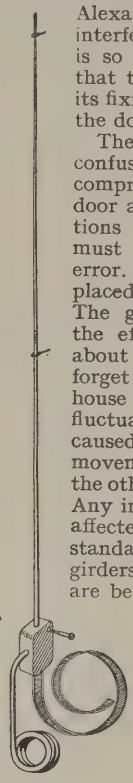
Most of the cars on the roads just now can be dealt with by unscrewing the central lead from the distributor, and in its place screwing a two shilling resistor,*5 into which the original lead will go. This is all that need be done unless car radio is fitted in which case the car should already be suppressed for optimum results.

Alexandra Palace Television in Cape Town

There have been an increasing number of cases reported, of very long distance reception of television. Sunspots are said to be responsible. The writer well remembers sitting up with an amateur in the very early 'twenties and hearing the first reported reception in the country, of American amateur transmissions. This soon became commonplace. It is appreciated that the two cases may not be comparable and "Belling-Lee" do not advocate the sale of television equipment outside the normal range of Alexandra Palace, except experimentally, but it is of interest to readers of this page that at least one viewer in Capetown reports that he was unable to resolve the picture until he had erected a "Belling-Lee" dipole and reflector.*6 Please note that no elaborate array was used.

A New Indoor Television Aerial

The "Doorod"*7 is a fully dimensioned half-wave dipole with one rigid and one flexible element for use within six or seven miles of Alexandra Palace and where interference is not severe. It is so named as it is thought that the most likely place for its fixing will be by the side of the door frame.



The "Doorod" must not be confused with miniature or compressed dipoles. All indoor aerials have their limitations and the best position must be found by trial and error. They should not be placed too near the receiver. The great thing to avoid is the effect of people walking about near the aerial. Don't forget that in a semi-detached house or in flats, there may be fluctuations in picture strength caused by the unconscious movements of neighbours on the other side of the party wall. Any indoor dipole will also be affected by the presence of standard lamps or metal pipes, girders, etc., even though they are behind plaster, bricks and mortar.

If an outside dipole is impossible, an inverted "V" in the loft will always give better results than any television aerial in the same room as the set.

*1 Flex lead suppressors. **L.301** (3 core), **15/6**. **L.1174** (2 core), **9/6**.

*2 "**Winrod**" window mounting aerial. **L.581, 19/6** each, sold in cartons containing 6.

*3 "**Skyrod**" anti-interference aerial. **L.638/K**, chimney mounting. **£10**.

*4 Set lead filter. **L.300/3, 59/6**.

*5 **L.630**, distributor suppressor, **2/-**.

*6 "**Viewrod**" television aerial. **L.502/C**, for mast mounting, **88/-**.

*7 "**Doorod**" indoor television aerial. **L.645, 30/-**. (Registration and patent applied for.)

The words "**Winrod,**" "**Skyrod**" and "**Viewrod**" are Registered Trade names.

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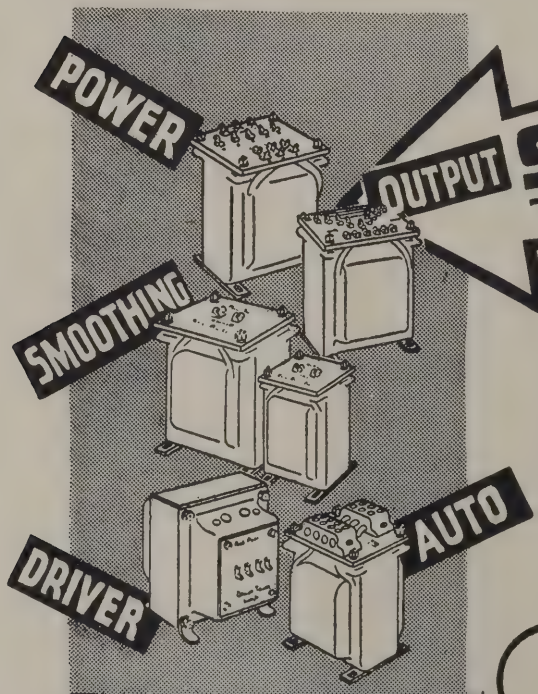

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WORLD OF WIRELESS

P.T. Concession ✦ Industry's Enterprise ✦ More Amateur Wavebands ✦ E.H.F. Broadcasting

P.T. on Communication Sets

AFTER consultation with the Radio Communication and Electronic Engineering Association, the Commissioners of Customs and Excise have agreed that, in general, receivers which are designed, and offered for sale solely for amateur or professional communication reception shall for the present be regarded as not chargeable with purchase tax. It is pointed out, however, that this exclusion from tax does not apply to sets which are of "the domestic or portable types used for the reception of public broadcast programmes."

Manufacturers of communication receivers are advised to secure confirmation of non-liability to tax from the Commissioners at City Gate House, Finsbury Square, London, E.C.2, submitting (in duplicate) full specification, descriptive literature and other appropriate information including frequency coverage, incorporation of B.F.O., ranges, wholesale price, etc.

Radiolympia

THE R.I.C. has announced the dates on which the 16th National Radio Exhibition will be held at Olympia this year—from September 28th to October 8th. There will be a preview with admission by invitation only on September 27th.

Interference Suppression

THE Radio Industry Council is to be congratulated on its efforts to correct misconceptions regarding the effect and cost of suppressing electrical equipment causing interference with radio and television reception. By staging a demonstration at the height of the debate on the Wireless Telegraphy Bill, of types of interference and its suppression, it gave Members of Parliament, Press representatives and manufacturers an opportunity of obtaining first-hand knowledge of the main causes of interference and the most effective methods of suppression.

Technical members of the staff of the manufacturers, whose identity was not revealed, gave convincing demonstrations of the interference caused by vacuum cleaners, thermostatically controlled electric irons and electric dry shavers and, too, of the effect of fixing a flex-lead suppressor costing 9s 6d. It was not possible to demonstrate the effect on television reception of suppressing car ignition interference. However, by installing two aerials—one at a normal height of about 25 feet and the other at about 120 feet—and switching from one to the other, visitors were shown how good television can be when ignition interference is eliminated.

Amateur Frequencies

WHEN the provisions of the Atlantic City Telecommunication Convention come into operation on January 1st a number of additional or extended wavebands will become available to amateurs in this country. Amateurs will then be permitted to operate in the following bands, but those marked with an asterisk are released on a non-interfering basis:—

Mc/s	Mc/s
1.715 - 2.0	144 - 146*
3.5 - 3.635	420 - 460*
3.685 - 3.8	1,215 - 1,300*
7.0 - 7.3	2,300 - 2,450
14.0 - 14.4	5,650 - 5,850
28.0 - 30.0	10,000 - 10,500

Frequency modulation as well as amplitude modulation will be permitted on all bands from 420 Mc/s upwards and on all these, as well as on 144-146 Mc/s, an input power of 25 watts will be permitted.

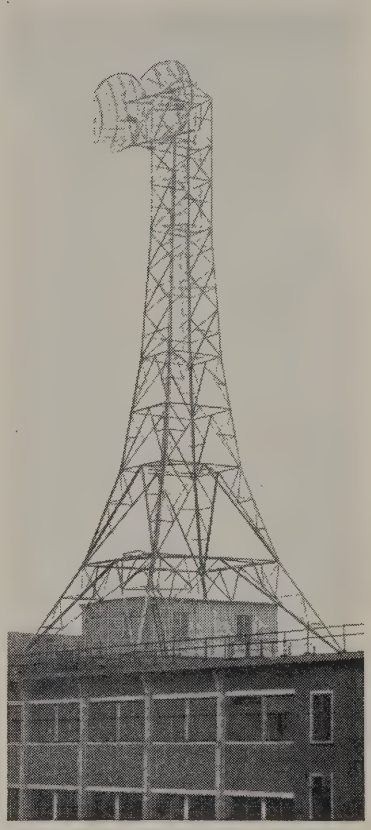
The R.S.G.B. has negotiated with the G.P.O. for the retention of the 5-metre band (58.5-60 Mc/s), allocated to television, and this has been granted temporarily.

B.B.C. on E.H.F.

IN the very small amount of space devoted to the engineering side of broadcasting in the 1949 *B.B.C. Year Book*, reference is made to the research which has been undertaken to determine the possibilities of common-wave working on ultra-short waves.

Elsewhere in this 190-page book of general information for the broadcast listener and viewer, it is stated that as a long-term solution to the ever-growing congestion in the M.W. and L.W. bands, a chain of extra-short-wave stations is planned. In addition to the 25-kW frequency-modulation transmitter at Wrotham, Kent, an 18-kW A.M. transmitter is to be installed. Both transmitters will work in the 87.5 to 94.5-Mc/s band.

The *Year Book* costs 3s 6d.



TOWERING 175 feet above London's streets is this new aerial, the first of six to be erected between the capital and Birmingham for the television link. The paraboloids have built-in electrical heaters for de-icing. This terminal station, designed by G.E.C., is at the Museum telephone exchange, Tottenham Court Road.

City and Guilds Exams

READERS may like to be reminded of the dates on which entries to the various City and Guilds Examinations in radio subjects should be made.

Those proposing to enter for the Telecommunications Engineering examination, the Radio Service Work intermediate examination and that for the radio amateur's licence should make their entries through local technical colleges or the local education authority by March 1st.

Candidates for the Radio Servicing Certificate final examination should apply to the Secretary, Radio Trades Examination Board, 9, Bedford Square,

World of Wireless—

London, W.C.1, by February 1st on the special entry form obtainable either from the City and Guilds, Department of Technology, 31, Brechin Place, London, S.W.7, or from the R.T.E.B. When candidates' eligibility has been confirmed by the R.T.E.B. they should enter for the written papers in accordance with the normal C. and G. procedure, i.e., through a technical college or local education authority.

The dates given apply only to candidates in Great Britain and Northern Ireland.

Radio Regulations

A PHOTOSTATIC copy of the English version of the Radio Regulations annexed to the Atlantic City International Telecommunication Convention has been issued by the G.P.O. This volume, of some 300 pages, includes such generally useful information as the complete tables of frequency allocations to the various services, international call signs, revised classification of types of transmission and the "Q" codes. It is obtainable from H.M. Stationery Office, price 3s 6d.

Sir Edward Appleton

THE appointment of Sir Edward Appleton as Principal and Vice-Chancellor of Edinburgh University was announced at the end of November. This means that he will be leaving the Department of Scientific and Industrial Research. He has been Secretary of the Committee of the Privy Council for Scientific and Industrial Research since 1939.

Sir Edward, who was recently awarded the Valdemar Poulsen Gold Medal by the Danish Academy of Technical Sciences for "outstanding contributions to radio technics and particularly for remarkable achievement in research on the ionosphere," was Wheatstone Professor of Physics at London University from 1924 to 1936. He was Jacksonian Professor of Natural Philosophy at Cambridge from 1936 to 1939. His ionospheric researches are too well known to need reiteration.

He was knighted in 1941 and a year ago was awarded the Nobel Physics prize. Among the positions now held by Sir Edward, who is 56, are: chairman of the B.B.C. Scientific Advisory Committee, president of the International Scientific Radio Union and a member of the Government Television Advisory Committee. He is a Fellow of the Royal Society.

Radio Research

THE appointment of a new member to the Radio Research Board (see "Personalities") makes it opportune to give some information on its constitution and functions. There are at present sixteen members of the Board which advises the Lord President of the Council (as the Minister responsible for D.S.I.R.) on radio research matters in general and in particular on what research should be undertaken. The decisions made by the R.R.B. are put into effect by Dr. R. L. Smith-Rose, who is Director of Radio Research at D.S.I.R.

The present members of the Board are:

Sir A. Stanley Angwin (Chairman), Cable and Wireless; Prof. H. E. M. Barlow, Professor of Electrical Engineering, University College, London; F. S. Barton, Director of Communications Development, M.o.S.; H. Bishop, Chief Engineer, B.B.C.; E. Brundett, Controller of Physical Research, Admiralty; A. J. Gill, Engineer-in-Chief, G.P.O.; Brig. J. B. Hickman, Director of Telecommunications Research and Development (Defence), M.o.S.; Dr. L. G. H. Hanley, Electrical Engineering Dept., Birmingham University; Sir N. Johnson, Director of Meteorological Office, Air Ministry; Capt. E. M. Knapp, Director of Radio Equipment, Admiralty; Prof. H. S. W. Massey, University College, London; J. A. Radcliffe, Cavendish Laboratory, Cambridge; Air Com. F. H. Richardson, Director of Signals, Air Ministry; Prof. F. J. M. Stratton, Deputy Scientific Adviser to the Army Council, War Office; Dr. H. W. H. Warren, Managing Director, B.T.H.; and G. M. Wright, Engineer-in-Chief, Marconi's.

Slow Morse Transmissions

READERS wishing to learn morse may be interested to have details of the latest schedule of slow morse transmissions radiated by a number of amateurs whose efforts are co-ordinated by C. H. L. Edwards, G8TL, 10, Chepstow Crescent, Newbury Park, Ilford, Essex. The times are G.M.T.

Monday

20.00	1900 kc/s	G2AJU (Stutton, Ipswich).
20.00	1800 kc/s	G2DJS (Bradford).
21.00	1900 kc/s	G3BLN (Bournemouth).

Tuesday

22.00	1896 kc/s	G8TL (Ilford).
23.00	1820 kc/s	GM4AN (Kirkaldy).

Wednesday

22.00	1800 kc/s	G3DLC (Grays).

Thursday

22.00	1896 kc/s	G2BCX (South Woodford).
22.30	1803 kc/s	G3OB (Manchester).

Friday

19.00	1900 kc/s	G3BLN (Bournemouth).
20.00	1900 kc/s	G2AJU (Stutton, Ipswich).
20.00	1860 kc/s	G3AKW (Wirral).
20.30	1868 kc/s	G8LZ (Gravesend).
23.00	1820 kc/s	GM4AN (Kirkaldy).

PERSONALITIES

Sir Ernest Fisk, managing director of E.M.I., has been given the Silver Medal of the Royal Society of Arts for his paper on "The Development of Sound Recording and Reproduction" read before the Society last session.

E. G. ROWE, M.Sc., who has joined Standard Telephones and Cables.

W. S. Barrell, technical director of E.M.I Studios, who is president of the B.S.R.A., recently visited the U.S.A. and during his stay addressed the Audio Engineering Society in New York.

G. M. Wright, B.Eng., Engineer-in-Chief of Marconi's W.T. Co., has been appointed a member of the Radio Research Board of D.S.I.R. During the war he was at the Admiralty and became Chief Scientist at the Admiralty Signal Establishment. He returned to Marconi's as Engineer-in-Chief in 1946. Prior to his war service he was head of Marconi's research department.

G. M. WRIGHT, B.Eng.

E. G. Rowe, M.Sc., who has been with the M.O. Valve Co. since 1933 and for the past eight years has been in charge of valve design and development, has resigned to join Standard Telephones and Cables, where he will be in charge of valve engineering and technical control of production. He has been a member of the B.R.V.M.A. Technical Committee for some years and has served as its chairman for the past two years.

IN BRIEF

Licences.—A record monthly increase of 7,200 in the number of television licences in force was recorded at the end of September, when the total was 73,800. The number of broadcast receiving licences (including television) in force in Great Britain and Northern Ireland was 11,329,400.

Cost of Television.—In reply to a question in the House, the P.M.G. stated that whereas the cost of operating the B.B.C. television service during the financial year 1947-48 was £700,000, the gross revenue from television licences for the same period was £91,100.

Magnetic Recording Standards.—A committee has been set up by the British Standards Institution to consider the standardization of terms, engineering practice, etc., for magnetic recording. The chairman of the committee is M. J. L. Pulling, vice-president of British Sound Recording Association. Three sub-committees have also been formed to deal with magnetic sound film; disc and tape; and wire. The chairmen are Dr. O. K. Kolb, R. W. Lowden and P. T. Hobson, respectively.

Can Electronics Help?—During his opening speech at the Electronics Symposium organized by the Scientific Instrument Manufacturers' Association, Sir Edward Appleton stated that the Department of Scientific and Industrial Research had set up a small group of advisers to visit firms with a view to assisting them in assessing the possibilities of using electronic equipment in industrial processes.

Railway Radio.—After six years' experimenting a new V.H.F. train radio system is being introduced in Sweden. F.M. equipment operating on approximately 2 metres with a range of 20 km is to be used, it having been found the most satisfactory in view of the extensive electrification of Swedish railways. The service is not yet available to passengers.

Denmark's new 50-kW S.W. broadcasting station at Herstedvester, near Copenhagen, operates daily from 2400-0130 G.M.T. on 9.520 and 15.165 Mc/s.

British Council Scholarships.—It may not generally be known by overseas readers that scholarships are awarded to overseas graduates or to others of like status to help them to undertake a year's specialized study at a British university, college or other educational institution. Particulars are obtainable from the offices of the British Council, 3, Hanover Street, London, W.1, or from Government representatives overseas.

"Britain Goes Ahead."—Radio is featured at the "Britain Goes Ahead" exhibition being staged at Charing Cross London Transport Station. Muirhead photo-telegraphic equipment, linked by line to Cable and Wireless headquarters, is being demonstrated. Two television sets—Cossor and Ekco, a Hughes supersonic flaw detector and a "Rebecca" transmitter-receiver made by E.M.I. are also on view.

Radio S.E.A.C.—It is understood negotiations are being made for the transfer of control of the Forces broadcasting station, Radio Seac, in Colombo to the Ceylon Government. It is to be known as Radio Ceylon. The 7.5-kW transmitter radiates on 6.075, 7.185, 9.520, 11.770, 15.120, 17.730, 17.770, 17.820, 21.470 and 21.620 Mc/s.

Ionosphere Research.—A permanent ionosphere research station is being established in Singapore. The experiments are to be conducted by the Ionosphere Recorder Team of the U.K. Department of Scientific and Industrial Research, whose officer in charge, B. W. Osborne, has arrived in Singapore.

Canadian Television.—Applications have been made to the Canadian Broadcasting Corporation for licences to erect six privately operated television transmitters. Four are for Toronto and two for Montreal. The Corporation has recommended that they should not be licensed until agreement has been reached on the questions of technical standards and co-operative action by private and national interests.

Business Radio Licences are now being issued by the Australian Government to newspapers and utility services.

D.S.I.R.—The headquarters administration of the Department of Scientific and Industrial Research (excluding the Intelligence and Overseas Liaison Divisions) has been transferred to Dorland House, 14-16, Regent Street, London, W.1 (Tel.: Whitehall 9788). The Intelligence Division is at 4-12, Regent Street, and the Overseas Liaison Division at Africa House, Kingsway, London, W.C.2.

Industrial Electronics.—A special course of six lectures on electronics in industry, by L. I. Farren, of G.E.C. Research Laboratories, will be given on Fridays at 6.30 at the Regent Street Polytechnic, commencing on February 4th. The fee for the course, which covers ultrasonics, R.F. heating and control systems, is 10s. Enrolment forms are obtainable from the Head of the Electrical Engineering Department, 307, Regent Street, London, W.1.

C.G.I.—In the 1947 report of the City and Guilds of London Institute, it is shown that there was an increase of 3,813 in the number of entrants for the telecommunications engineering group of examinations compared with the previous year. The year's total was 18,754.

Noise in the Home.—A report on the results of a survey to obtain information on the incidence of noise in houses and flats, published by H.M.S.O. under the title "A Survey of Noise in British Homes," shows that although the sound of neighbours' radio is "noticed" by the largest proportion of the 2,000 people questioned, it was considered by them to be much less troublesome than what is classed "banging of doors."

Australian F.M.—For some time the Postmaster-General's Department has been conducting tests with F.M. transmitters in Melbourne and Sydney. The Government has now announced its intention to proceed with F.M. as a service in all the capital cities of Australia. No licences will be issued to commercial broadcasters and the service will be controlled by the Government.

"World Radio Handbook," the fourth edition of which is now available, is being distributed in this country by Wm. Dawson and Sons, Cannon House, Macklin Street, London, W.C.2. Printed in English, although published in Denmark, the book, which costs 6s 6d, gives information on the world's broadcasting stations and schedules of regular transmissions.

N.P.L. "**Open Days**" will be held next year on May 26th for representatives of industry and 27th for members of university staffs and Government Departments.

Exhibitions.—The 1949 British Industries Fair will be held in London and Birmingham from May 2nd to 13th. The 26th *Daily Mail* Ideal Home Exhibition will be held at Olympia from March 1st to 26th.

Great Circle Map.—In our note on the new edition of the *Wireless World* Great Circle Projection Map in last month's issue, the cost, including postage and packing should have been given as 3s.

Radio in the House.—It has been announced that it is hoped to provide facilities for the reception of broadcast and television programmes in the new House of Commons.

INDUSTRIAL NEWS

Hunt-Mycalex.—The world selling rights for the Mycalex capacitor, which in future will be known as the Hunt-Ingram capacitor, have been taken over from the Mycalex Company by A. H. Hunt, Ltd., of Bendon Valley, Garratt Lane, Wandsworth, London, S.W.18, to whom all enquiries should in future be made.

Marconi marine radar and radio apparatus is being installed in the new 28,000-ton Orient liner *Orcades*. The equipment includes the M.I.M.C. Co.'s new Mercury and Electra marine receivers. The Mercury is a medium and long-wave receiver covering the frequencies 15 to 40 kc/s and 100 kc/s to 4 Mc/s. The Electra is principally for

FERRY RADAR. The London Midland Region of British Railways has installed Cossor radar equipment at its Riverside Station, Tilbury, which, together with Marconi R.T. gear on the steamers, enables the ferry service to be maintained in foggy weather. The transmitter operates on a frequency between 9,425 and 9,524 Mc/s. The indicator unit has three ranges—0.8, 1.2 and 3 nautical miles. In this photograph of the display a ferry can be seen leaving the landing stage.

World of Wireless—

short-wave work but covers the frequencies 250 to 520 kc/s as well as 1.5 to 25 Mc/s. Both receivers are capable therefore of reception on the calling and distress frequency of 500 kc/s. A wire recorder forms part of the ship's sound-reproducing equipment.

Marconi communications equipment, to the value of £15,000, has been ordered by the government of Saudi Arabia The equipment consists of short-wave R.T. and C.W. transmitters which will provide a communications network linking the principal cities of Saudi Arabia. The company is also supplying two-way V.H.F. radio-telephone equipment to the Singapore police. Two 200-watt transmitters will be installed on high ground in the interior of the island and will operate in double-diversity. The transmitters, spaced several miles apart, will be controlled by a 10-watt transmitter at the police headquarters.

T.C.C. has acquired the premises of S. G. Brown, Ltd., adjacent to their own factory in North Acton. The additional space will be used for development and research work. The company asks us to correct two errors which appear in their advertisement in the December issue. The price of the Visconol capacitor Type CP58QO should be 15s and the maximum working voltage 7,000.

Pye television equipment was recently used in Cambridge by the town's Accident Prevention Council to transmit on a closed circuit scenes from a busy thoroughfare during a "Safety First" campaign. The amplifiers and control equipment were linked by 1,500ft of cable to receivers at the road safety exhibition.

Beethoven.—All departments of Beethoven Electric Equipment, Ltd., have been transferred from Chase Road, London, N.W.10, to the company's new factory at Chapel Lane, Sands, High Wycombe, Bucks (Tel.: High Wycombe 1152-3).

Scophony, Ltd., has taken over two companies—John Logie Baird, Ltd., who have recently introduced a television receiver incorporating a mains aerial, and its associated transformer manufacturing concern, W. Andrew Bryce and Co.

H.M.V.—For the benefit of the eighty or more delegates from overseas parliaments and legislatures attending the recent meeting of Empire Parliamentary Delegates in London, H.M.V. installed a television receiver with a 15-in C.R.T. at the Savoy Hotel where throughout the conference the delegates took their meals.

Portable Record Player.—The price of the Vidor battery-operated record player was incorrectly given in our last issue. It is 14 guineas *exclusive* of tax.

Wolsey Television, Ltd., which recently moved to 75, Gresham Road, Brixton, S.W.9, has now changed its telephone number to Brixton 7566.

E.I.B.A.—The Electrical Industries Benevolent Association benefited to the extent of over £500 as a result of the Electrical Industries Ball recently held at Grosvenor House.

French Television.—The system developed by the firm Radio-Industrie is to be officially adopted. According to a Government decree, the national system will have a definition of 819 lines with positive modulation and A.M. sound. The 455-line transmitter now serving the Paris area will remain in operation until January 1st, 1958. It is expected that the first high-definition transmitter will be installed in Paris in 1949 and that a second station will be built at Lille in 1950.

Philips organization has recently established a factory in Sao Paulo, Brazil, for the manufacture of radio receivers and electric lamps.

"F.B.I Register."—Nearly 1,000 pages, giving details of the members of the Federation of British Industries and their products, are included in the 1948-49 edition of the "F.B.I. Register" which was published last month. The price is 42s. Home orders should be sent to Kelly's Directories, Ltd., 196, Strand, London, W.C.2, and overseas orders to our Publisher.

EXPORT

South Africa.—Agencies from British manufacturers for radar, R.F. heating, communications and P.A. equipment and electronic control and testing apparatus are required by Dowson and Dobson, Ltd., P.O. Box 7764, Johannesburg. Further information can be obtained from the Export Promotion Department, Board of Trade, Thames House North, Millbank, London, S.W.1, quoting reference E.P.D. 42959/48.

Philco (Overseas), Ltd., is the name of the recently formed British subsidiary of the Philco Corp. of Philadelphia, U.S.A., for the purpose of selling British-made Philco products in all export markets. The managing director is R. W. Cotton, who was with British Rola until 1945.

Ceylon.—It is reported by the U.K. Trade Commissioner at Colombo that there is a wide scope in Ceylon for a moderately priced receiver, about Rs250 (£18 15s), covering short and medium waves.

MEETINGS

Institution of Electrical Engineers

Radio Section.—"Double-ratio A.C. Bridges with Inductively Coupled Ratio Arms," by H. A. M. Clark, B.Sc. (Eng.) and P. B. Vanderlyn, and "A Direct Capacitance Aircraft Altimeter," by W. W. Watton, B.Sc., and M. E. Pemberton, on January 11th. (Joint meeting with Measurements Section.)

"Some Aspects of Design of Balanced Rectifier Modulators for Precision Applications," and "The Effects of an Unwanted Signal Mixed with a Carrier Supply of Ring-and-Cowan Modulators," by D. G. Tucker, D.Sc., Ph.D., on January 12th.

"Should British Universities Consider the Establishment of Special Degrees in Radio." Discussion opened by Prof. E. B. Moullin, M.A., Sc.D., on January 18th.

"Small Power Transformers for Aircraft Electrical Equipment," by A. Langley Morris, on January 20th. (Joint meeting with the Measurements and Utilization Sections.)

The above meetings will be held at 5.30 at the I.E.E., Savoy Place, London, W.C.2.

Cambridge Radio Group. — "The Testing of Communication-type Receivers," by W. J. Bray, M.Sc. (Eng.), and W. R. H. Lowry, B.Sc., at 6.0 on January 11th at the Cambridgeshire Technical College.

Mersey and North Wales Centre.—"Communication of Technical Ideas," by H. E. Dance, M.Eng., at 6.0, on January 19th, at 24, Dale Street, Liverpool. (Joint meeting with the Liverpool Engineering Society.)

North - Western Radio Group.—"Three Dimensional C.R.T. Displays," by E. Parker, M.A., and P. R. Wallis, B.Sc. (Eng.), at 6.30, on January 19th, at the Engineers' Club, Albert Square, Manchester.

South Midland Centre.—Faraday lecture on "Television," by Sir Noel Ashbridge, B.Sc. (Eng.), at 6.0, on January 25th, at the Town Hall, Birmingham.

South Midland Radio Group.—"Television Developments," by K. R. G. Sturley, Ph.D., at 6.0 on January 24th, at the James Watt Memorial Institute, Great Charles St., Birmingham.

Western Centre.—"A Resumé of V.H.F. Point-to-point Communication," by F. Hollinghurst, B.Sc. (Eng.), and C. W. Sowton, B.Sc., at 5.0 on January 10th, at the South Wales Institute of Engineers, Park Place, Cardiff.

Sir Noel Ashbridge's Faraday lecture on "Television" at 6.30 on January 19th, at the Victoria Rooms, Bristol.

British Institution of Radio Engineers

London Section.—"Developing an Indicator Unit for H_2S Equipment," by R. T. Croft, at 6.0 on January 20th, at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

South Midlands Section.—"Telecommunications in Turkey," by A. E. Harrold at 7.0 on January 27th, at the Technical College, The Butts, Coventry.

Merseyside Section.—"Radar Experiments," by E. V. Jacobs, at 6.45, on January 5th, at the Incorporated Accountants' Hall, Derby Square, Liverpool, 2.

British Sound Recording Association

"Gramophone Record Processing," by E. D. Parchment, at 7.0 on January 28th, at the Royal Society of Arts, John Adam St., London, W.C.2.

Royal Society of Arts

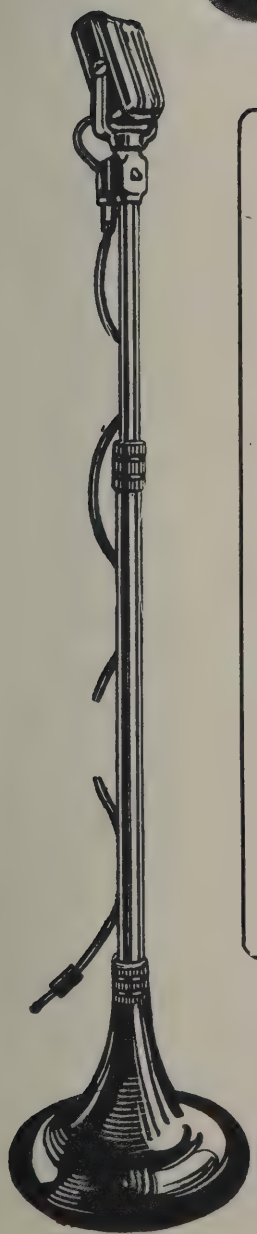
"Radar and its Application to the Science and Art of Marine Navigation," by Lieut. P. Satow, D.S.C., R.N., at 6.0 on January 4th at the R.S.A., John Adam Street, London, W.C.2.

Radio Society of Great Britain

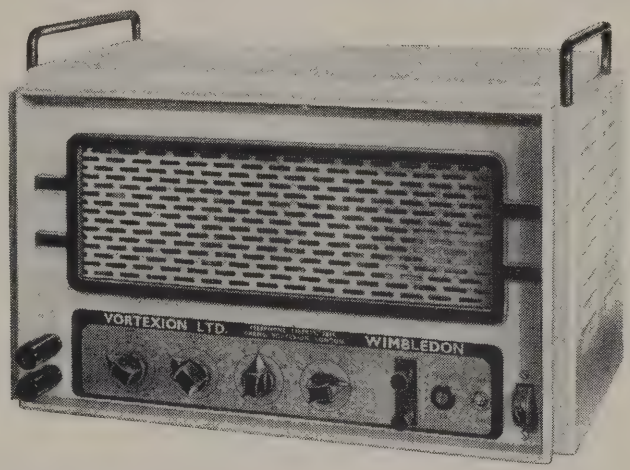
Annual General Meeting followed by a discussion on "420 Mc/s Work," opened by W. A. Scarr, M.A., and D. N. Corfield, D.L.C. (Hons.), at 6.30 on January 28th, at the I.E.E., Savoy Place, London, W.C.2.

Institute of Navigation

Three films on radio navigation systems with a commentary by R. F. Hansford, at 5.30 on January 10th, at the Royal Geographical Society, 1, Kensington Gore, London, S.W.7.



"SUPER FIFTY WATT" AMPLIFIER



This AMPLIFIER has a response of 30 c/s. to 25,000 c/s. within ¼db, under 2 per cent. distortion at 40 watts and 1 per cent. at 15 watts, including noise and distortion of pre-amplifier and microphone transformer. Electronic mixing for microphone and gramophone of either high or low impedance with top and bass controls. Output for 15/250 ohms with generous voice coil feedback to minimise speaker distortion. New style easy access steel case gives recessed controls, making transport safe and easy. Exceedingly well ventilated for long life. Amplifier complete in steel case, with built-in 15 ohm mu-metal shielded microphone transformer, tropical finish. *As illustrated,* Price **36½ Gns.**

All types of MICROPHONES, STANDS and SPEAKERS available from stock including 12 in. GOODMAN P.M. SPEAKER

●

30-Watt RECORD REPRODUCER in metal case
PRICE **30½ Gns.**

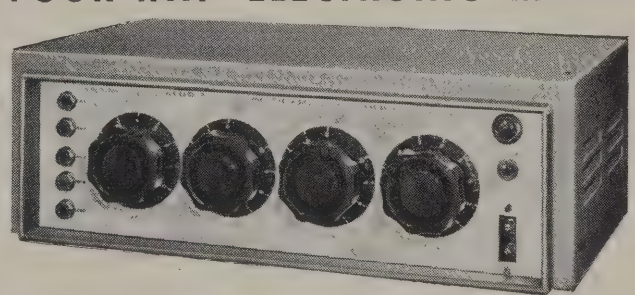
●

10-Watt RECORD REPRODUCER with MICROPHONE STAGE, in case
PRICE **25½ Gns.**

●

CP20A AMPLIFIER for A.C. Mains and 12-volt Battery
PRICE **£28.0.0**

FOUR-WAY ELECTRONIC MIXER



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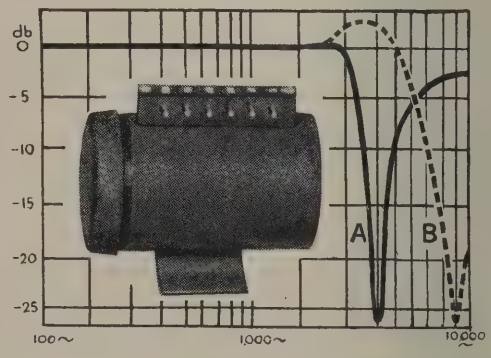

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ADMITTANCE

Better Than Impedance for Some Calculations

By "CATHODE RAY"

THE only units associated in the minds of most people with admittance are shillings or other monetary quantities. In print, such association is peculiarly binding and rigid, not readily set aside except perhaps by ingenious and agile boys. But in the pages of this journal, admittance if mentioned at all would generally be reckoned in mhos. My impression is that it is not mentioned at all, or (at most) rarely. Writers assume, I think, that although impedance is understood, admittance might not be, and so go out of the way to avoid it. It is different in the learned stratosphere of *Wireless Engineer*, of course.

I have not hired a Mass Observation Service but rely entirely on guesswork for the following order of familiarity in which I place the electrical "-ances." Resistance is easily first, followed at some distance by impedance and reactance. Impedance can be mentioned in circles of doubtful technicality with rather more confidence than reactance, though perhaps the day has passed when reactance was often understood to mean the thing that squealed if you turned it too far clockwise. Conductance may actually be encountered earlier in the pursuit of learning than impedance, but is soon discarded when it is found to involve a different and rather queer-looking unit of measurement. Admittance, as I said, is hardly legal tender even among *Wireless World* readers; and as for susceptance. . . .

Choice of System

What I want to do is to show that the admittance-conductance-susceptance group of terms has other uses than for throwing about to create an impression of unscalable height of brow. Anyone who is familiar with impedance, resistance and reactance ought to have no difficulty with them and should soon be able to choose whichever group is the more suitable for the job in hand.

In the very early stages we learn that resistances in series can simply be added to give the total resistances:

$$R = R_1 + R_2 + R_3 \text{ etc.}$$

When we come to resistances in parallel the thing looks awkward in print:

$$R = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \text{ etc.}}$$

and the arithmetic of working it out is still more awkward. Conducting paths in parallel are reckoned much more simply as conductances, when the formula corresponds exactly to resistances in series:

$$G = G_1 + G_2 + G_3 \text{ etc.}$$

The relationship, of course, is

$$\text{Conductance (G)} = \frac{1}{\text{Resistance (R)}}$$

That is all very well, you may say, but the values of "conducting paths" are always given in ohms, and to convert them to mhos, add them up, and convert them back to ohms, is exactly what one does according to the clumsier formula. And it wouldn't be any solution to mark series resistances in ohms and parallel resistances in mhos, because sometimes a resistance is both in series and in parallel at the same time. If they were all marked in both units it would be very convenient for adding them and inconvenient in every other respect. In practice it has to be one or the other. Although conductors are, on the whole, more important than resistors, it is not so often important to know their numerical values; so it is natural for ohms to be used rather than mhos.

When one has become used to reckoning quantities in one unit it is very difficult to think of them in another unit. That is why ridiculous units like stones and jars take so long to die out. Although the fact that I have understood the official meanings of V.H.F., U.H.F., S.H.F. and E.H.F. since their inception is proof (according to the Editor) that I have phenomenal ability to absorb new ideas, I confess that after all these years I still have to convert frequencies to wavelengths to know where I am with them, in the medium waveband at least. So I do agree that there is some ground for a prejudice against methods of reckoning that necessitate different units for the same things—and not even directly-proportional units, easy to convert.

A New Symbol?

Mhos are handicapped in another way by having been allotted no abbreviation. Ohms have their Ω, but the only thing one can do with mhos, other than writing the word out in full, is to say "amps per volt" and abbreviate it A/V. And of course the same for mA/V and μA/V to stand for millimhos and micromhos. This roundabout system is actually used in this country for mutual conductances. But can you imagine anybody tolerating the volt-per-amp as a unit of resistance! So the sooner the poor mho is given a symbol the better My suggestion is ʊ. I shall probably be told that in handwriting it would be mistaken for v. But that objection seems to have been successfully overruled in the case of ω and w.

By the way, the name "mho" itself has from birth suffered the stigma of doubtful legitimacy. I believe that when it was brought up for consideration by the appropriate international body the German representative objected on the ground that it was derogatory to Dr. Ohm to have his name officially reversed for any purpose whatever; so as part of the appeasement programme it was dropped. It seems a good chance now, before we are obliged to adopt the zhdanov or

Admittance—

the vishinsky, to get mho fully instated.

Talking about mutual conductance, it is rather curious that this has become generally accepted, even by the assistant who sells valves over the counter. Seeing that nearly everybody thinks in terms of resistances rather than conductances, one would have expected to find r_m, the mutual resistance. The ratio of r_a to r_m would be μ. Since one conductance (even in mA/V !) seems to have got by, why not others ?

Take the output resistance of a valve, for instance. That is to say, the resistance the valve appears to have from the point of view of the load. In a straightforward amplifier it is equal to r_a. According to the usual "valve equivalent circuit" (Fig. 1b), this resistance is in series with the load, causing the voltage available across the load to be less than that generated in the valve (μv_g). In a pentode, μv_g and r_a are generally both very large, and it is often more helpful to think in terms of the alternative (but much less used) "equivalent," Fig. 1(c). Here the valve is considered as generating a current, $g_m v_g$, some of which (but not much in a pentode) is wasted in the shunt r_a. R_L and r_a being in parallel, it would be convenient to treat them as conductances were it not that they are usually specified in ohms. Besides, Fig. 1(b) is an easy enough circuit to calculate when it is as simple as shown. In practice, however, one often has to take account of several paths in parallel; for example, stray capacitances across valve and load. A series-parallel circuit is always awkward to calculate; it is much easier to have all one or the other, and that is where Fig. 1(c) may help.

Then think of the cathode follower, where one effect of the 100 per cent negative feedback is to alter the output resistance from r_a to $\frac{r_a}{\mu + 1}$. This is usually manipulated into $\frac{1}{g_m + \frac{1}{r_a}}$. If one were to work in conductances, it would be converted into the simpler form $g_m + g_a$, where g_a is the anode conductance $\left(\frac{1}{r_a}\right)$. And if there were a cathode resistor R_c to be taken into account, its reciprocal, G_c, could simply be added. Apart from arithmetic, some people may see the cathode follower more clearly as two conductances in parallel across the output terminals than as a resistance divided by $\mu + 1$.

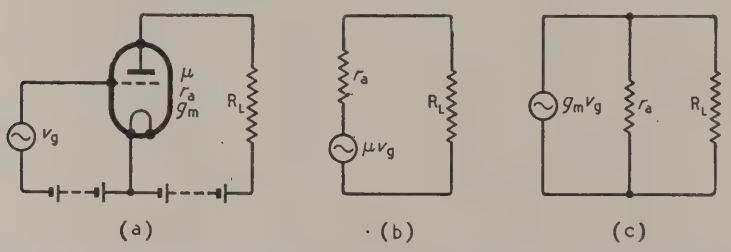

Fig. 1. Simple valve amplifier circuit (a), and the usual theoretical equivalent (b). For some purposes it is more helpful to use the alternative equivalent (c).

I haven't forgotten that the title of this article is Admittance. But we are going to get round to it via that unfrequented passage, susceptance. Susceptance stands in relation to reactance as conductance does to resistance; that relationship, of course being reciprocal. And its symbol is B; so $B = \frac{1}{X}$.

Reactances as all radio men know, are of two kinds—inductive and capacitive. The formula for inductive reactance ($X_L = 2\pi fL$ or ωL) is simple and convenient and as inductances are more often in series than in parallel (being rather like resistances in that respect) there is seldom much inducement to dabble with inductive susceptances.

Capacitances on the other hand, habitually occur in parallel; and it is a happy circumstance that the total is calculated so simply, by just adding them. But when—

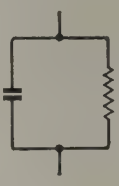

Fig. 2. This is an extremely simple circuit, but is not at all simple to calculate in terms of resistance, reactance and impedance. It is quite easy in terms of conductance, susceptance and admittance.

as often happens—it is necessary to work in capacitive reactances, it is quite a different matter. Even converting a single C to X_c or vice versa, usually with large negative powers of 10 coming into the calculation, is bad enough on paper and quite maddening mentally. And if there are several capacitive reactances in parallel, they have to be combined the awkward way, like resistances. So capacitive susceptance

($B_c = 2\pi fC$ or ωC)

is by comparison rather a pleasant thing to use. If f is in c/s and C in F, or f in Mc/s and C in μF, B will be in mhos; and if f is in Mc/s and C in pF, B will be in micromhos.

A very common combination, especially in high-frequency work, is C and R in parallel (Fig. 2). That is because stray capacitances are everywhere. Now just consider what happens when one works out the impedance of this very simple combination. The result, in one form, is

$$Z = \frac{1}{\sqrt{\frac{1}{R^2} + \frac{1}{X_c^2}}}$$

Or using the j technique one can work it into a form without any square root:

$$Z = \frac{X_c R(X_c - jR)}{X_c^2 + R^2}$$

That doesn't look very attractive, either. But in terms of conductance and susceptance nothing could be simpler:

$$Y = G + jB$$

Here at last we have managed to gain admittance, denoted by Y. It is reciprocal of Z.

For example, the maker's data concerning a certain valve include:

Input resistance at 50 Mc/s 4,000 Ω

Input capacitance 8.3 pF.

From these, $G = 250$ μmhos and $B = 2\pi \times 50 \times 8.3 = 2600$ μmhos. So the admittance is $250 + j\,2600$ μmhos. Since B is so much greater than G, there will not be much difference in the values of B and Y. (Try working it out, $Y = \sqrt{250^2 + 2600^2}$). The input of the valve looks like a capacitor with a rather poor power factor—somewhere near 10 per cent.

If at any time it is necessary to use inductive susceptance, one thing to remember is that it is negative; the opposite way round to reactance, of which the capacitive kind is negative.

Another possibly catchy point is that although $G = 1/R$ and $B = 1/X$ when R and X are alone or in parallel, it is not so when R and X are in series. Then $G = R/(R^2 + X^2)$ and $B = X/(R^2 + X^2)$.

But that is getting on to book work. All I am anxious to do is to show that admittance-conductance-susceptance is not a good set of things to know nothing about. Besides being useful for working out actual quantities in circuits, they make it easier to talk and think clearly about circuits in general. For instance, suppose we are explaining how valve amplification at, say, 50 Mc/s differs from that at 1 Mc/s or lower. There is, we say, a marked tendency for amplification to be less, because of the input impedance of the valve. That is not clear, because the more input impedance the valve has the better. We might say "because of the lowness of the valve input impedance;" but "lowness of impedance" is really a clumsy way of saying "admittance."

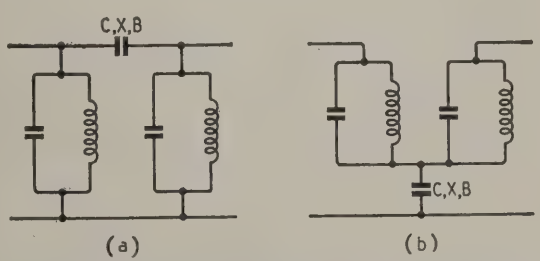

Fig. 3. While the coupling in (b) is appropriately said to be due to the reactance X, in (a) it is better to ascribe it to the susceptance, B.

Or one might say that the coupling in the filter circuit shown in Fig. 3(a) depends on the capacitance, C. That may be roughly true, but is not precise, because 10pF at 2 Mc/s has more effect than at 1 Mc/s. It would be true in a sort of way to say the coupling depends on the reactance, X. But it is an upside-down sort of way, for the greater X is, the less the coupling. The most precise and simple statement is that the coupling depends on the susceptance, B; being, in fact, very nearly directly proportional to it. In Fig. 3(b), however, it would be most appropriate to say that the coupling depends on X.

When discussing the behaviour of a valve it is advisable to make clear what sort of theoretical equivalent you are considering. Are you regarding it simply, as in Fig. 1, as something that gives a certain voltage out when a voltage is put in at the grid, and shunts the output terminals with a certain resistance (or conductance if you have Fig. 1(c) in mind!)? Or are you taking into account the valve susceptances; that is to say, the A.C. paths provided by the inter-electrode capacitances, regarding them as pure or loss-free capacitances? Or, more exactly still, are you taking account of the valve admittances; allowing not only for the inter-electrode capacitances but also for their losses? Use of the correct terms may not make understanding of your meaning certain, but it will make it more probable.

So much for admittance and its component parts.

There may be room this month for a more general note. Many of the subjects I discuss in these pages are those which readers have written to me to say they have difficulty in understanding. Provided that I am not expected to write individual replies, I am glad to receive such letters, especially from readers overseas who may find it difficult to get light on their problems. They should be addressed to "Cathode Ray," c/o *Wireless World*.

New
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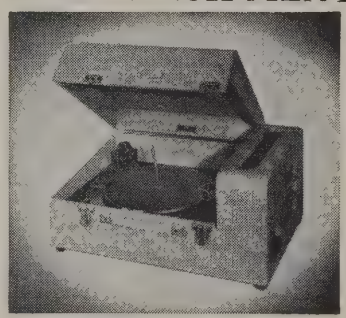

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AMPLIFIERS · MICROPHONES · LOUDSPEAKERS

SHORT-WAVE CONDITIONS

November in Retrospect : Forecast for January

By T. W. BENNINGTON and L. J. PRECHNER (Engineering Division, B.B.C.)

DURING November, while the average daytime maximum usable frequencies for these latitudes were much higher than in October, the night-time M.U.F.s were somewhat lower than during that month, in accordance with the seasonal trend.

Owing to the exceptional amount of ionosphere storminess working frequencies were rather lower than expected, and, so far as is known, very few long-distance contacts were made on the phenomenally high frequencies which became usable during the winter of 1947/48. However, there was occasional reception of harmonics of U.S.A. and South America transmissions on frequencies of the order of 50 Mc/s, as well as frequent reception of U.S.A. police transmissions in the 40-Mc/s band. Owing to storminess, reception on the 28-Mc/s band was often none too good, and there was also considerable attenuation on the lower night-time frequencies.

Abnormally high rate of incidence of Sporadic E for this period of the year was recorded, the value being higher than in October. It is worth noting that during the last few months both the rate of incidence of Sporadic E and the duration of disturbed reception conditions have been abnormally great, which may perhaps point to some connection between these two sets of phenomena.

Long-range tropospheric propagation was observed on very few occasions, mostly at the beginning and the end of the month. This propagation was probably due to the favourable weather conditions; for example, the widespread fog towards the end of the month.

Sunspot activity in November was less than in October. Two fairly large groups were observed, which crossed the central meridian of the sun on the 18th and 20th respectively. However, the latter group had already started decreasing rapidly on the 17th.

The month was again exceptionally disturbed, although rather less so than in October. The disturbances usually lasted for a long period. Ionospheric storms were observed on 1st-6th, 18th-25th and 27th-28th, those occurring on 2nd, 4th, 20th-23rd being particularly violent.

Very few "Dellinger" fadeouts have been recorded in November, and none was really severe.

Forecast.—There should not be much change in either daytime or night-time M.U.F.s as between December and January. Therefore, daytime M.U.F.s will be, as in December, probably lower than during November, because of the mid-winter effect in the northern hemisphere. However, daytime working frequencies will still be relatively high, and long-distance communication on very high frequencies should therefore be possible in all directions from this country. The 28-Mc/s amateur band should be regularly usable at suitable time of the day, but conditions on higher frequencies for long-distance contacts will not be as favourable as in November. The night-time M.U.F.s will fall to their lowest values for the winter, so that the night-time working frequencies will be as low as 7 Mc/s over many long-distance circuits, and they will be in use for relatively long periods.

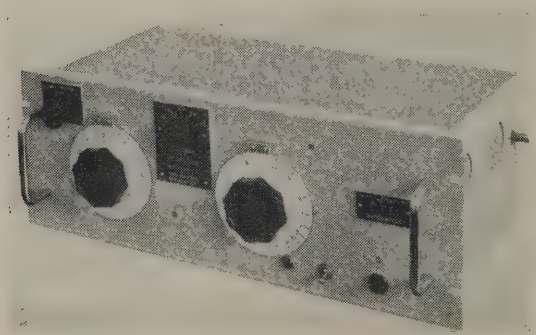
Below are given, in terms of the broadcast bands, the working frequencies which should be regularly usable during January for four long-distance circuits running in different directions from this country. (All times are G.M.T.). In addition, a figure in brackets is given for the use of those whose primary interest is the exploitation of certain frequency bands, and this indicates the highest frequency likely to be usable for about 25% of the time.

Montreal :	0000	7 Mc/s	(11 Mc/s)
	1000	9 ,,	(12 ,,)
	1100	11 ,,	(15 ,,)
	1200	17 ,,	(23 ,,)
	1300	21 ,,	(27 ,,)
	1400	26 ,,	(33 ,,)
	1700	21 ,,	(28 ,,)
	1800	17 ,,	(24 ,,)
	1900	15 ,,	(22 ,,)
	2000	11 ,,	(17 ,,)
	2100	9 ,,	(14 ,,)
	2300	7 ,,	(10 ,,)
Buenos Aires :	0000	9 Mc/s	(13 Mc/s)
	0400	7 ,,	(11 ,,)
	0700	9 ,,	(16 ,,)
	0800	15 ,,	(20 ,,)
	0900	21 ,,	(28 ,,)
	1000	26 ,,	(32 ,,)
	1900	17 ,,	(25 ,,)
	2000	15 ,,	(20 ,,)
	2200	11 ,,	(16 ,,)
	2300	9 ,,	(13 ,,)
Cape Town :	0000	9 Mc/s	(13 Mc/s)
	0200	7 ,,	(11 ,,)
	0600	15 ,,	(20 ,,)
	0700	21 ,,	(32 ,,)
	0800	26 ,,	(34 ,,)
	1500	21 ,,	(29 ,,)
	1800	17 ,,	(25 ,,)
	2000	15 ,,	(22 ,,)
	2100	11 ,,	(16 ,,)
	2300	9 ,,	(13 ,,)
Chungking :	0000	7 Mc/s	(10 Mc/s)
	0500	9 ,,	(14 ,,)
	0600	15 ,,	(21 ,,)
	0700	17 ,,	(24 ,,)
	0800	21 ,,	(29 ,,)
	0900	26 ,,	(33 ,,)
	1100	21 ,,	(27 ,,)
	1200	15 ,,	(19 ,,)
	1300	11 ,,	(15 ,,)
	1500	9 ,,	(12 ,,)
	1700	7 ,,	(10 ,,)

Ionosphere storms are not very frequent in January, but if they do occur during period of darkness they are very troublesome on account of the already very low ionisation prevailing during the winter night. At the time of writing it would appear that such disturbances are more likely to occur within the periods 4th/5th, 12th/14th, 17th/19th, 23rd/24th, than on the other days of the month.

SELECTIVE AMPLIFIERS

DESIGNED as an A.C. bridge amplifier, the Type GSA1 made by Mullard Electronic Products, Century House, Shaftesbury Avenue, London, W.C.2, is designed for the detection of harmonics in conjunction with a suitable indicator. A frequency range of 16 c/s to 200 kc/s is provided in five steps and the response is 20db down at $1.5f$ and 0.8 f, and 40 db down to $2f$ and $0.5f$, where f is the resonant frequency. Two feedback networks of the twin T null type are employed and give negative feedback of unwanted frequencies. The amplifier is designed for operation from A.C. mains (110-245 V, 50 c/s) and the dimensions are 19in by 7in by 10in for rack-mounting. The price is £82.



Mullard selective amplifier type GSA1. The controls include two variable frequency scales, frequency selection switch and gain control.

PORTABLE DISC RECORDER

Details of the H.M.V. Model 2300H

THE specification of this recording equipment is of a high standard and makes it suitable for professional and commercial applications as well as for home recording. It is divided into three units, the heaviest of which weighs 72½ lb; the total weight is 125 lb.

The recorder unit consists of an 18-lb balanced turntable, belt-driven by a 1/20 h.p. motor. Blanks from 5in to 13½in diameter can be accommodated. A protected lead screw gives a groove pitch of 95 to the inch, and there is a safety device which automatically lifts the cutter and stops the traverse at the minimum cutting diameter. A scale is provided which indicates the correct starting position for records of various diameters. The traverse clutch is engaged and the stylus is lowered on to the disc by a three-position lever.

The recording head is of the moving-iron type, and is said to have a frequency response flat within 3db from 50 to 8,000 c/s. An adjustment is provided for depth of cut, and the head is rotatable to facilitate the insertion of a fresh cutter. A small lamp is mounted on to the underside of the traverse arm to illuminate the disc in the vicinity of the stylus.

A lightweight play-back pickup is provided, and a swarf brush and groove inspection lens are included. The recorder unit also houses the power pack, the output of which is taken to the amplifier and control unit through a 10-way cable.

There are four stages in the amplifier, which delivers 8 watts from the push-pull output valves. Bass cut and top lift tone controls are provided, and a 4-way master control switch has positions for recording either from the low-impedance ribbon microphone supplied, or from a high-impedance source; also direct play-back, or "public address" using the microphone and monitoring loudspeaker. A jack is also provided for high-impedance monitoring headphones.

The loudspeaker unit is fitted to carry the microphone and all connecting cables. The case forms a baffle for the 10in elliptical permanent-magnet loudspeaker.

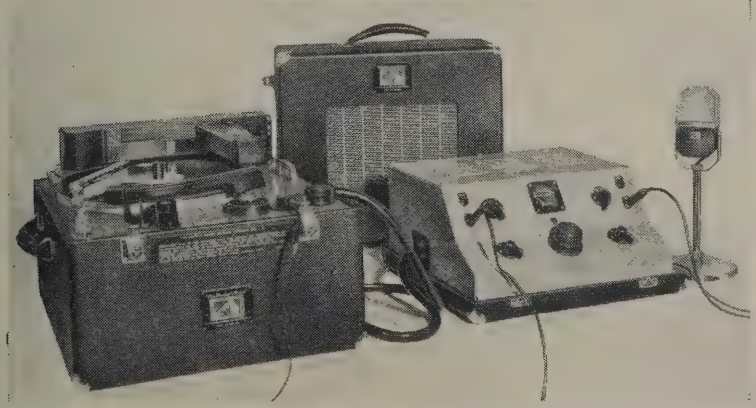
Operation of the equipment should present no difficulty, and the monitoring meter gives reliable indication of the recording level. An instruction book gives useful general information on the art of cutting good records, and when a little experience had been gained in controlling the swarf and learning the importance of a clean stylus, etc., we were able to produce some excellent noise-free recordings.

The makers are the Gramophone Company, Hayes, Middlesex, and the price of the complete outfit is £235, including tax.

MEASURING RECEIVER PERFORMANCE

MUCH useful technical information on methods of checking the performance of radio receivers and television sets is contained in a booklet "Radio Measurtests," issued by Marconi Instruments, Longacres, St. Albans, Herts. It assumes that faults have been traced and cleared and that it is desired to check that the performance has been restored to the required standard. Chapters are devoted to each of the following instruments and their applications: — Type TF888 receiver tester, Type TF894 audio tester, Type 887 valve voltmeter, Type TF899 valve millivoltmeter, and Type TF913 F.M. receiver tester.

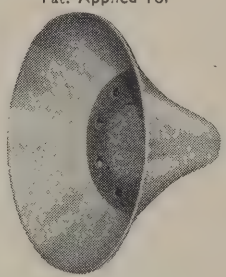
Copies of the booklet are available to servicemen who apply on business notepaper.



H.M.V. Model 2300H disc recorder. For transport, the equipment packs into three carrying cases.

NEW
ECONOMICAL
A Two-Purpose Loudspeaker which Saves Capital Expenditure

Pat. Applied For



Always there has been the difficulty in many applications, whether the Horn type loudspeaker with its high power possibilities, or the Cone type with its greater frequency range for the same size, is to be used for any particular installation. Both types have their advantages and limits. This new design by F.I. enables the major components of two types to be interchangeable. Main flare, fixing device and assembling nut are common to either of two assemblies. Add centre section and L.S.7. unit for a complete re-entrant horn type 42 REH, or add PAC 6 and special mounting to have a cone and directional baffle system : 42 RC.
Whichever type suits you most, you have the opportunity of acquiring the components for the alternative assembly when you are in need of them.

F.I. for P.A.
HORN LOUDSPEAKERS
CONE LOUDSPEAKERS
MICROPHONES

FILM INDUSTRIES LTD.,
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Telephone : WELbeck 2385

W.W.16

Unbiased

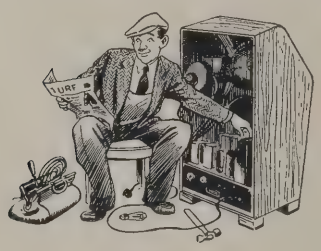
By FREE GRID

"Respice Finem"

I WAS greatly moved by the argument put forward by the unknown scribe in the October issue of *Wireless World* in defence of 405-line television; so much so, in fact, that I feel like addressing to him a suitable paraphrase of King Agrippa's famous remark. The trouble is, of course, to get the television-buying public to believe it. Most of them dwell in technical darkness and are an easy prey to the suggestion, which has undoubtedly been put into their minds by writers who ought to know better, that definition is directly proportional to the number of scanning lines and to nothing else. It is going to be a hard job to persuade them otherwise. The trouble is that the argument of "More lines, more detail" sounds so very logical on the face of it.

The whole thing is, of course, analogous to the idea which listeners got into their heads—or had put there—when broadcasting began, that range was directly proportional to the number of valves in their sets. The result of this was that no set manufacturer dare market any multi-valve receiver which did not by hook or by crook bring in an earful of strange noises.

Some semblance of stability was usually achieved in such sets by positively biasing the so-called H.F. valves, with the result that



A Radio Nero.

they became virtual passengers. I well recollect that one of the less scrupulous manufacturers almost made a fortune by adopting my suggestion that he make some of the valves real passengers by bypassing them altogether and feeding the input direct to the detector. In this manner he saved the expense of so-called potentiometers and other adjuncts to positive bias and actually increased the set's range by enabling the reaction control to be given its head unhampered and unhamstrung by damping devices. His advertisements were, I need hardly say, refused by *W.W.*, for obvious reasons, despite his specious arguments about the end justifying the means since his sets undoubtedly gave better results than those of manufacturers who remained within the fold. Unfortunately for the cause of morality he prospered, despite the words of the psalmist, and had the temerity to offer me a substantial cheque as commission, which, of course, I promptly refused.

To return to 1948, however, there is in my opinion only one way to deal with this insidious idea of "More lines, more detail." It is, to take the bold course and appear to yield to it by announcing that from a certain date B.B.C. transmissions will be on a thousand-line system and that technicians would call at viewers' homes to alter existing sets for a small fee. The technicians could then be instructed to take the back off each set and fiddle for an hour or so. Surely that shouldn't be too difficult in these days.

Heresy Column

I JUST hate to be a spoilsport and strike a discordant note in the Hallelujah Chorus that is being sung by radio writers everywhere over the provisions of the Wireless Telegraph Bill but, although, like Galileo, I may be in a minority of one, I cannot for that reason cast truth aside and bow to the popular clamour. Rather than eschew truth and live, I would have my say and then step into the waiting tumbril with a quiet mind and a stout heart.

Let me say first that as a lover of Anglo-Saxon I am glad that the P.M.G. follows the example of *Wireless World* and retains the good old English word "wireless" instead of the alien "radio." I am sorry, however, that the equally alien "telegraphy" is retained and this hybrid perpetuated. One might with equal lack of justification call this journal "*Wireless Spheroid.*" Since the act makes "telegraphy" embrace telearchy, telegoniometry and "Uncle Tom Cobley and all" why not turn the word "wireless" into an all-embracing noun as most listeners do anyway?

But my great complaint concerns the "interference" section of the Bill for it makes no mention of what is by far the worst and most offensive form of interference to the peaceful enjoyment of broadcast listening. Since it does not mention it, I take it that such interference will be allowed to go on unchecked. I rejoice with "Diallist" that the P.M.G. will no longer be tied down to ineffective polite requests so far as *electrical* interference is concerned but in the matter

The shadow of "the Widow."

of *acoustical* interference the P.M.G. will, I take it, still be fettered and forced to rely on the feeble and ineffective bleatings made during summer months by the B.B.C. regarding this nuisance.

This omission from the Bill means that the sufferer from this menace has only one legal weapon left to him and that is to buy a much larger amplifier and loudspeaker than the man next door and thereby achieve the results so graphically suggested by the line of the famous hymn where the author tells of volume so tremendous that it "drowns all music but its own."

Yet another injustice in the Bill is that by obtaining powers to control reflection as well as radiation the P.M.G. stops my enjoying my hitherto undoubted legal right of installing without a licence a private telegraph service by setting up a reflector near a V.H.F. broadcasting station and using and modulating some of the available energy. Almost the only freedom left is for me to sit up in the gallery of the House and warm my coupon-starved body with the hot air rising so freely from the floor.

But come, the driver of the tumbril is getting impatient and so are the ghoulish mob gathered round the foot of the steps leading up to "the widow" judging by the angry murmur I hear in the distance.

LETTERS TO THE EDITOR

Trade Delays • Sound Reproduction Level • Thoughts on the Copenhagen Plan • Bi-directional Aerial • Voltage Multipliers • Dial Lamps • Are Signal Meters "Useless"?

Export Drive

IN my report of the R.C.M.F. October show in Stockholm (your December issue) I mentioned the need for more information. May I add a footnote to my report? Messrs. X have now written to tell me that their catalogue will appear in February. My old friend Y still has not sent me the samples he promised within a week: I even offered him cash—sterling or kronor. This sort of thing really will not sell components, even to a willing buyer.

YOUR CORRESPONDENT.
Stockholm.

"*Siting*" *of Radar Sets*

FOR twenty years I have sat at "Free Grid's" feet and have listened, with wonder and admiration, to his views on many subjects: but when he waves an angry umbrella at the word "sited" (*Wireless World,* December, 1948), I must draw my own gamp in its defence.

It was found early in the war that the accuracy of elevation measurement on the radar set GL Mk. 1 (with Bedford attachment) was dependent on the irregularities in the surrounding terrain. Later, on 200 Mc/s, it was found that the amount of clutter on Early Warning sets depended greatly on the positioning of the set in relation to the natural contours of the ground. Later still, on 3 cm, it was found that a change of position of the radar set of only 20 yards could turn a bad, cluttered presentation into a good one.

Some concise word was required that should mean "choosing the spot of ground that best suits the radar set." *Location* was already in use with another specialized meaning; *position* and *place* were in general and ill-defined use; *site* had the right connotation of dependence on terrain, and was adopted.

Its chief disadvantage was the possible confusion between "siting trials" and "sighting trials."

If the Southend equipment was put on the roof regardless of technical requirements, then I agree with "Free Grid" that there are better words; but if its position was deliberately chosen with care for field of view, for avoidance of local horizons and for freedom from clutter, then Site is Right.

IAN B. R. CATER.
Aberporth, Cardiganshire.

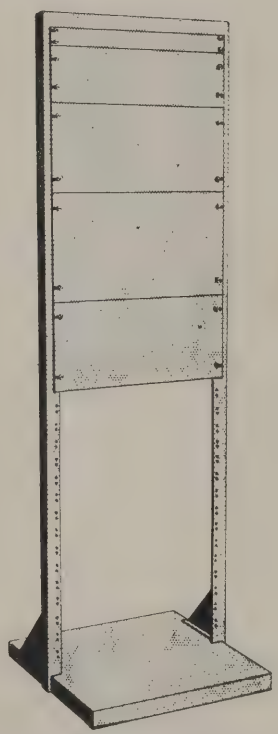
"*Scale Distortion—Again*"

I APPEAR to have trodden somewhat heavily on "Cathode Ray's" corns (*Wireless World,* November) by saying that in his article in the March 10th, 1938, issue he "had been advocating remedies for scale distortion" and that he visited the Queen's Hall ". . . to prove that there was such a difference between the actual and reproduced levels of sound that a weighting network was necessary. . . ."

I should have mentioned that I had also been reading his original article of September 24th, 1937, in which he said about scale distortion: "Is there any way of getting over the difficulty? I know of no automatic this or that which can be fitted into the receiver to do the job. The only solution is to make intelligent use of a fairly flexible system of tone control." Also in the same article appears: "But there is still one condition, and an awkward one . . . . The programme must be reproduced at the original volume. When a military or dance band, a symphony orchestra or a cathedral organ are playing with all their might, the original intensity of sound must be reproduced in the home listening room." In the March 10th, 1938, article describing the Queen's Hall measurements he said: "I will admit right away that there was a closer agreement between the original loudness and what could be done with an ordinary receiver at home than I had supposed."

In other words, he went to the Queen's Hall to prove his article of September 24th, 1937, correct in all aspects, but was compelled by the results to modify his beliefs on the total power required for comparable pressures in the home. To me the most valuable part of "Cathode Ray's" work was the establishment of 1½W for this power level instead of the 15 to 18W normally quoted.

And now the STANDARD RACK



Latest edition to the Imhof range of cases is the new Standard Rack and Panel assembly. Of heavy gauge mild steel angle, it is strongly constructed with welded corners, and finished in grey stove enamel. Standard 19" Rack panels of ⅛" thick mild steel plate are available in four sizes:—1¾", 5¼", 8¾" and 10½" deep finished in grey stove enamel.

Prices:—

Standard Rack frame 5' 6" high		£4 15s. 0d. each
Panels	19" × 10½"	11s. 3d. ,,
,,	19" × 8¾"	8s. 9d. ,,
,,	19" × 5¼"	5s. 7d. ,,
,,	19" × 1¾"	3s. 2d. ,,

Plated chassis with associated mounting brackets 15s. per set

IMHOF'S

PRECISION BUILT INSTRUMENT CASES

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Telephone: MUSeum 5944

Letters to the Editor—

I do not therefore feel that "Cathode Ray" has any ground for such strong statements as misrepresentation and corruption, but I leave it to your readers to judge. I may have been guilty of wrong emphasis; if so, I humbly beg his pardon. H. S. CASEY.

Beckenham, Kent.

"Metering Programme Appeal"

I DO not think that "Diallist" (your December issue) can be accused of exaggeration when, after an outline of the Danish programme appeal checking system, he states that "The system has a good few limitations." Surely the domestic wireless receiver is not the only type of electrical equipment which causes harmonic distortion in the mains? What of accumulator charging rectifiers, etc.?

Also, will not the amount of distortion produced depend largely upon the type and condition of the receiver? There must be a big difference between the results obtained from A.C. and A.C./D.C. sets, for example. N. MORLEY.

Cranwell, Lincs.

Copenhagen Broadcasting Plan

THANKS are due to *Wireless World* (November) for publishing such a complete survey of the Copenhagen wavelength plan.

While the completion of any such plan obviously represents a very considerable achievement in present conditions, a preliminary study suggests the following reflections:—

(1) The number of listeners who tune to foreign stations has progressively declined, due largely to the increasing difficulty of receiving them satisfactorily, and the listener who wishes to hear stations other than those in his own country should have a rather better chance under the new plan than at present.

This applies especially to the long waveband, which has been almost useless to many people for some years. Further, most countries have at least some clear channels in the medium waveband.

(2) Certain countries seem to have emerged from the conference with much improved allocations, in some cases out of all proportion to the state of their broadcasting development.

(3) The increasing tendency towards still higher powers will cause some misgivings, particularly in respect of the long-wave transmitters. At the present time, "Luxembourg effect" practically ruins reception of a few otherwise satisfactory medium-wave stations on the Continent, and with powers increased to 400 kW and over, this seems likely to become a serious problem.

(4) Surely the tardy allocations to Germany must cause trouble in the long run; without entering into politics, Germany has had one of the most developed broadcasting systems in Europe, and also a high proportion of licence holders. The allocation of only two channels to each zone (both shared and one below 200 m) with a third for the occupying forces, seems bound to lead to "piracy" at some future date.

(5) The continuance of the B.B.C. European Services with anything like the present coverage would appear to be impossible with the new allocations. G. H. STURGE.

Welwyn Garden City,
Herts.

New Aerial

A SHORT-WAVE receiving aerial developed in our laboratories by T. S. Popham, for use overseas, may be of interest to your readers.

The problem posed was that of providing radio programme inputs for a rediffusion system in Trinidad from transmitters located at London and New York. An obvious solution would have been to provide rhombic aerials; double diversity reception requiring a total of four such aerials. However, the amount of space available at the receiving site would not permit of this arrangement and an alternative was devised.

This new bi-directional aerial is based upon the following appreciation:—

The radiation pattern of a single

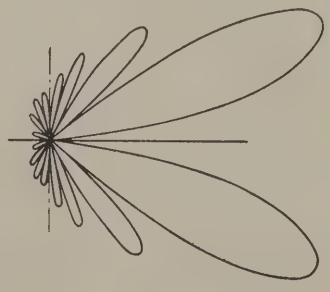


Fig. 1

straight horizontal wire carrying a progressive wave is of the form shown in Fig. 1, the pattern being a figure of revolution about the wire as axis. If now a second wire be placed parallel to the first in the same horizontal plane and fed in opposite phase a new pattern will arise due to the addition of the effects of each individual wire. By adjusting the distance between them suitably, a state can be achieved where reinforcement of the radiation takes place in four directions lying in the cone of maximum radiation of the single wire and being symmetrically disposed on either side of the horizontal and ver-

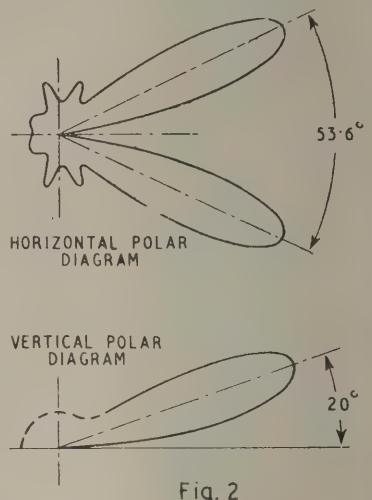


Fig. 2

tical planes through the common axis of the wires, while cancellation will take place in the vertical plane through the axis of symmetry of the wires. If, further, these two wires are placed horizontally above a "perfect" earth and their height suitably adjusted, cancellation will take place in the horizontal plane while reinforcement takes place in two directions having the same angles of elevation and lying on either side of the axis of the wires. This arrangement exactly met the requirements.

If the lengths of the wires are reduced, the angle between the two lobes increases and the lobes themselves become broader, the radiation pattern tending to a figure-of eight form. Thus for reasonable directional properties and gain, the angle between the two lobes must not exceed 90°. If the lengths of the wires are increased the angle between the two lobes is reduced and the lobes become longer and narrower. Hence the only limitation to reduction of the angle between the lobes is that of the physical size of antenna which can be tolerated, while the performance of the antenna will steadily improve as the length is increased.

Experiments made with a model working on a wavelength of 9 cm gave the radiation pattern shown in Fig. 2. In practice the two wires are fed in "push-pull" and terminated by a resistance so that there is no reflection at the far end.

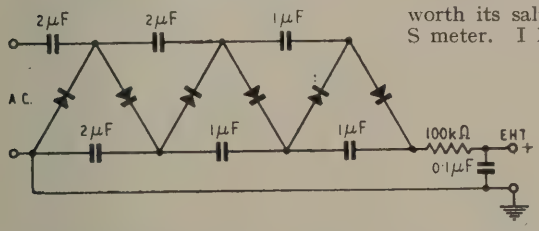
The pattern will, of course, be modified by the presence of an imperfect earth and by the exact details of the termination, but the above example gives a simple picture of the mode of operation of this new aerial.

R. P. GABRIEL, Chief Engineer,
Central Rediffusion Services, Ltd.
London, S.W.1.

E.H.T. for Oscilloscopes

MANY readers must have been intrigued, as I was, by the article in *Wireless World* for May, 1948, describing voltage multiplier circuits. Faced with the problem of providing E.H.T. for a modified version of the oscilloscope mentioned in the same issue, I decided to use a multiplier for the purpose. The straightforward Cockcroft-Walton circuit was preferred for its simplicity, and as the input voltage was to be 250V A.C., a three-stage network was envisaged. Obviously a unit bulkier than the "Westeht" was inevitable, because the latter has to supply only the beam current for a television tube, whereas an oscilloscope calls for the rather heavier potential-divider current also. Hence larger capacitors than those used in the "Westeht" were indicated.

Accordingly 1-μF paper condensers and 30-mA type selenium rectifiers (both Government surplus) were employed in the circuit shown;



the smoothing condenser, of course, was a high-voltage type. The whole assembly, mounted on a paxolin base to insulate the condenser cases, measured 12in × 5in × 3½in. The total cost was less than £1.

The smoothed output voltage fell from 2,100V at no load, to 1,500V for a load current of 1.5mA. This denotes a regulation (inclusive of smoothing) of approximately 2% per 100 μA change. The ripple voltage at the multiplier output, with 1.5 mA load, is shown by the formulæ to be about 10%; the smoothing will reduce this to 1.5%. Hence the regulation and ripple are rather better than they need be. This, however, does not permit reduction of the reservoir capacities, since even with 1 mA drain the output falls by 400 V from the maximum.

With an input of 350 V A.C., a two-stage multiplier should give approximately the same output, and improved regulation. C.A.R.

Series Capacitor Heater Circuits

WHEN in my letter appearing in the October issue of *Wireless World*, I drew attention to the limitations of use of capacitors, I made no reference to dial lights.

These, like all other components, have their drawbacks which I enumerate as follows:

(1) Designed for intermittent use in torches, these "flash lamp" bulbs have a nominal life of only ten hours under conditions of continuous operation at full rated voltage.

(2) Such lamps operate at incandescence whereas valve heaters function at bright red heat.

(3) This dissimilarity of operating conditions make the important consideration to be the voltage across the lamp rather than the current flowing through it.

(4) The peak voltage across the lamp, for even short periods, should be restricted to roughly 1.25 times the rated voltage if a reasonable life is to be obtained.

J. PARKINSON.
Uxbridge, Middx.

Value of an S Meter

IT appears an accepted fact that no modern communications set is worth its salt unless fitted with an S meter. I have often wondered if this fitment has any real value.

As an amateur transmitter it has more than once puzzled me why a local station should give an S5 report "according to the meter" which another 30 or 40 miles away upsets soon after by reporting that it is an S8 signal. According to the accepted standard that is something like 8 db difference in signals.

The type of aerial must make a vast difference while if S1 on the meter is taken as receiver noise level, the design of the pre-selector stages must play a significant part.

Four or five gradations of signal strength should suffice, not nine, while for telephony a report such as loud and clear is more useful than S8 which incidentally is only the carrier level and takes no account of the modulation depth. Is there any justification for the S meter, apart from a modified form for telegraphy reports? G2MC

Pinner, Middlesex.

M. WILSON LTD

Mr. and Mrs. Wilson and Staff wish all Wireless World readers a Merry Christmas and a Happy New Year

Now available from stock

A NEW TUNING H.F. UNIT. 6 wavebands 5-2000 metres with High Gain R.F. stage.

Brief Specification

1 R.F. stage, F.C. with separate Oscillator, 1 stage of I.F., using our new I.F. Transformers, iron cored, permeability tuned, with a Q of 155, feeding into second detector of the cathode follower type, using our new Audio filter unit.

Fitted with its own power pack and smoothing ready to attach to any good L.F. Amplifier

Controls

Main tuning control, no band-spread required. Sensitivity control working on the first R.F. valve. I.F. gain control with selectivity control incorporated. 6 wave-band switch.

The chassis is built of 16 s.w.g. Aluminium, rigid corners. Box type 6 wave-band coil unit, fitted with our latest iron cored, high Q coils, completely screened.

A.V.C. Magic eye tuning indicator. Measurements 9½in. x 8½in. x 11in. high.

A limited supply is available from stock.

We honestly believe this to be the finest Tuning Heart on sale, for sensitivity, selectivity and the High Fidelity obtained on the Medium waveband, due in measure to the cathode follower detector valve with its distortionless output, in conjunction with its filter system.

Price on application

As above but with three wavebands, Long, Medium and Short (16-50). Not available in Kit form.

BLUE PRINT SERVICE

Full size practical (above and below chassis) and theoretical blue prints for circuits of :
6 wavebands with 2 R.F. stages, 14 valves, 15/- per set ; 6 wavebands with 1 R.F. stage, 9 valves, 7/6 per set ; 3 wavebands with Aerial and Osc., 5 valves, 7/6 per set ; 3 wavebands with A. and Osc. Battery, 4 valves, 1.4v., 7/6 per set ; 2 wavebands with A. and H.F. T.R.F., 5 valves, 7/6 per set.

Audio Frequency Filter Choke Unit. Size 3in. x 2in., 15/-.

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LONDON W.C.1. 'Phone: HOLborn 4631

RANDOM RADIATIONS

By "DIALLIST"

New Magnetic Alloy

A NEW MAGNETIC ALLOY, which seems to possess remarkable qualities, was announced during this autumn's meeting of the British Association. It is a lineal descendant of the nickel-aluminium-cobalt-iron family, but it differs from its predecessors in containing a minute percentage of the rare metal niobium. It appears that an alloy containing the above-mentioned four basic ingredients *plus* a small amount of vanadium was produced for use in jet propulsion engines, in which it proved most successful. Then it occurred to someone to investigate its magnetic properties and it was found to have unexpectedly high coercivity. The Permanent Magnet Association and the Electrical Research Association collaborated in experiments and it was suggested that even better results might be found if niobium, which belongs to the same group in the periodic table of the elements, were used instead of vanadium. This has proved to be the case and in the new alloy, of entirely British origin, we have a metal which seems superior to anything in the world in its resistance to de-magnetization. The old idea that iron was capable of only temporary magnetization and that steel was required for permanent magnets must go by the board. Like Alnico, the new alloy, which doesn't yet seem to have been given a name (how would "Niobalnic" do?) can't be classed as a steel; for, though it consists of some 56 per cent of iron, it has no carbon content.

Sea-spray Ducts

A CURIOUS EFFECT has been noticed recently in some of the radio links used to enable the telephone service to span wide estuaries or to connect small islands with the mainland. The E.H.F. transmitters and receivers and their aerial systems are usually designed for ample coverage of the distances involved but not for any greater range. It was found that at times some of the signals could be received strongly at distances two or three times as great. This freak effect has not yet been completely investigated; but the data so far obtained appear to show that rough water caused by high winds and an air temperature some degrees below that of the water form the combination of weather conditions in which reception at phenomenal distances is most likely to occur. In such circumstances the air above the surface of the water may become laden with salt spray up to a height of many feet above the surface of the water. It is suggested that in this way ducts, or wave-guides, may be formed in the air which have bending effects on centimetre waves very similar to the summer-time atmospheric ducts which are often responsible for reception at ranges far beyond the quasi-optical.

U.S.A. Television Standards

IT IS EXCEEDINGLY difficult to obtain any reliable information concerning the ranges of modulation frequencies sent out by transmitting stations or faithfully dealt with by receivers in the United States. This is perhaps understandable in the case of transmitters, which have been installed and are being operated by a number of different bodies. So far as I can discover there is no standard adopted—or at any rate aimed at—by all. Each transmitter is erected and worked as a commercial proposition which must pay its way, either directly by the advertising revenue brought in, or indirectly by promoting the sales of television receivers made by those who finance it. The quality of the transmission is, therefore, likely to depend largely on the capital that its owners are willing to invest in the station and the extent of the possible short-term losses that they are prepared to stand with a view to long-term profits. As regards televisors, manufacturers are largely content to lay stress on the wonderful performance of their products, without giving data about the bandwidth that can be handled by their amplifying stages. If my calculations are right, the modulation frequency range required to produce a 525-line, 30-image-per-second display with a balance of horizontal and vertical definition as good as that of our 405-line, 25-image pictures is in the neighbourhood of 5.5 Mc/s. I make bold to doubt whether any normal U.S.A. transmitter or any receiver sold in the ordinary way for home use can deal with anything like this enormous frequency range.

A Form of Astigmatism

Unless the horizontal and the vertical definition, or "sharpness" are evenly balanced the result is to produce on the screen of even the best designed and most carefully corrected C.R.T. what amounts to a form as astigmatism. The eyes of those who suffer from ocular astigmatism cannot focus an object in both horizontal and vertical axes simultaneously. If you suffer from such astigmatism, your oculist prescribes glasses which correct it by giving a shorter (or longer) focus at the angle at which the focus of Nature's optical system is too long (or too short). I'm not suggesting that the optical axes are at right-angles to one another; the angle may be quite small. You can see what it is in your own case, if you have astigmatism, by looking at your oculist's prescription. But in television the two axes are at right-angles and, though the analogy isn't exact for this reason, an image with better vertical than horizontal definition may be likened to what a person suffering from optical astigmatism sees when he views the world without the help of glasses.

When is a Circle not a Circle?

One gathers that linearity is not the strong point of U.S.A. television in general. Here's a quotation from the American journal *Radio-Electronics* which is illuminating. An article telling servicemen how to make the best use of the test patterns which some stations radiate says:—

"Many TV owners are extremely fussy about having the circles exactly round. Some of them check the circles by holding a small plate in front of the screen and others measure the wedges to see if they are of equal lengths. In some TV areas this makes life extremely difficult for the television technicians,

because it is an unfortunate fact that some stations do not transmit good linearity. Also, the linearity may be different from one camera to another. In one particular city, if the receiver is adjusted so the test-pattern circle is round on the first station, the second station will be egg-shaped vertically and the third station will be egg-shaped horizontally . . ."

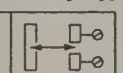
The test patterns are nothing like so elaborate as those sent out by the B.B.C. One understands why "in a few test-patterns all circles are intentionally omitted." Our transmissions are pretty good as regards linearity; but I'm far from claiming that all receivers are equally blameless. Perhaps it's fortunate for servicemen that few of our viewers display fussiness about the roundness of circles!

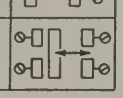
Good Luck to It

ONE HOPES THAT the clauses of the Wireless Telegraphy Bill which deal with interference won't be so toned down before the Bill becomes the law of the land that they will become more or less ineffectual. If television is ever to have the success it deserves as a form of home entertainment, the P.M.G. must be armed with powers sufficient to enable him to prevent the radiation of interference with its reception. The effects of interference on television and broadcast reception can be so devastating; the cure is, as a rule, neither difficult nor costly. The rather pumped-up stuff about the invasion of privacy struck me as just silly. After all, the men who read the gas and electricity meters already have a right of entry into the home and no one minds that. If you have a telephone, the Post Office people are entitled to take a look at it if they suspect either that it is out of order or that you have fitted unauthorized gadgets to it. Should you create a nuisance by keeping pigs under your next-door-neighbour's back windows, you'll have the sanitary inspector round fast enough. Then why shouldn't the P.M.G. inspector descend upon you, if you create a nuisance by spoiling the broadcast or television reception of your neighbours? A while ago someone invented the silly word "snooping." It has since been run to death, and, having become what A. P. H. would call a "witch word," should be avoided by sensible people.

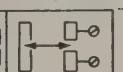
BULGIN
SWITCHES

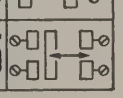
Glazed-Porcelain-Body-Types :

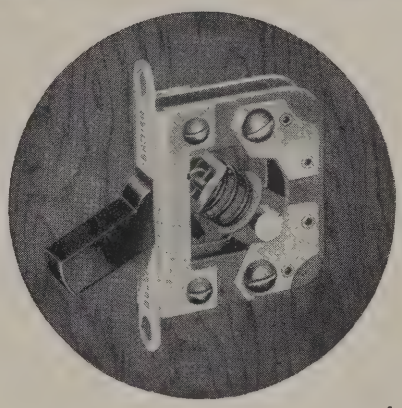
S.53 

S.55 

S.R.B.P.-Board-Body-Types :

S.393 

S.395 



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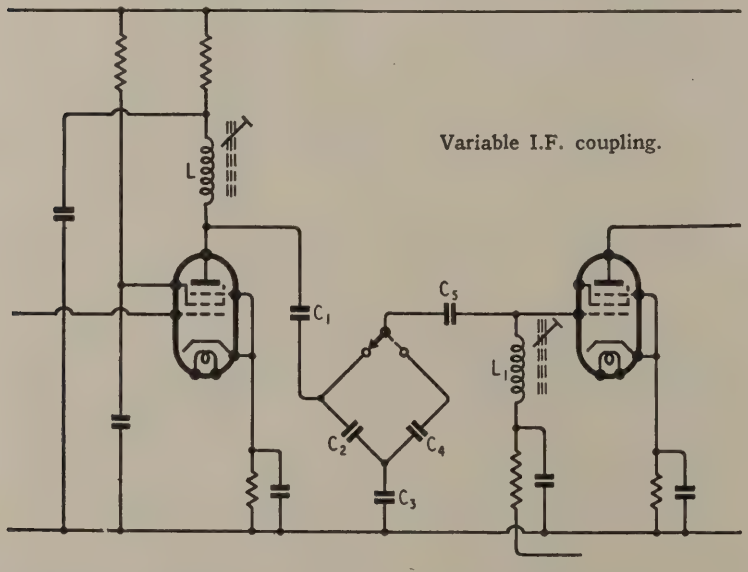
Intervalve Couplings

THE diagram shows a pair of I.F. amplifiers connected by a network which allows the coupling to be increased without altering the tuning of either of the circuits, though causing the peaks of their frequency response curves to move further apart.

Coupling is controlled by means of a switch S, and three star-connected condensers, of which C2 and C4 are equal in value, whilst C3 is always common to both the valve circuits. With the switch in the full-line position, the anode circuit L, C1, C2, C3 of the first amplifier is coupled to the grid circuit L1, C5, C2, C3 of the second amplifier through the common condensers C2 and C3. When the switch is moved over to the right, the tuning is unaltered, because the condenser C4 is equal in value to C2. The coupling between the two circuits is, however, changed from that due to the condensers C2 and C3 in series, to that due to the condenser C3 alone, the extent of the change, and the resulting shift of the resonance peaks, being determined by the comparative values of the two condensers concerned.

Murphy Radio, Ltd.; P. C. Cullen; and C. C. Holmes. Application date, November 24th, 1944. No. 598662.



Variable I.F. coupling.

Radar Indicators

WHEN a land-based installation is used for detecting the approach of aircraft, the echoes returned from nearby fixed objects, such as local buildings and hills, are often sufficiently powerful to mask the traces given by the craft under observation, particularly at close range. The application of gain control to the amplifiers offers one possible remedy, though it is difficult, in practice, to fix an optimum value for the control. If the gain is high it makes it easier to detect an aircraft at long range, though harder to follow once its echo comes inside the reach of the accentuated "ground clutter." On the other hand, if the gain is kept low the intensity of the ground echoes is certainly reduced, but so, too, is the distance at which it is possible to detect an approaching aircraft.

According to the invention, the amplifiers are subjected to a gain control which changes from a fixed high value during the period of one time-base sweep, to a fixed low value during the next sweep, and so on, in alternate cycles. The gain-control voltages are developed by a known type of multivibrator circuit, which is triggered from one to the other of its two conditions of stability by pulses derived from the time-base generator.

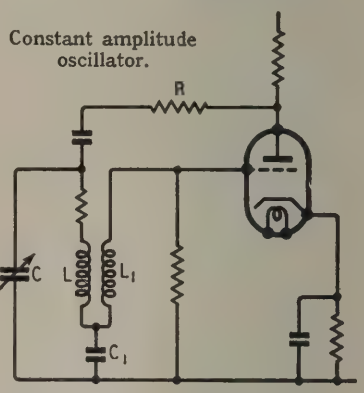
R. H. A. Carter. Application date, September 14th, 1945. No. 600494.

Oscillation Generators

THE circuit shown is characterized by the property of generating oscillations of substantially constant voltage over a considerable range of frequencies.

Feedback occurs through a resistance R connected in series with the main oscillatory circuit. This is connected across the grid, and consists of a tuning condenser C in parallel with a two-part inductance comprising a main coil L coupled to a grid coil L1, both in series with a fixed condenser C1.

The purpose of the coil L1 is to feed back to the grid from coil L1 the necessary fraction of voltage required to



Constant amplitude oscillator.

maintain the grid-cathode potential constant at all operating frequencies. A general formula equating the circuit values necessary to ensure this result (including the resistance of the coil L and its turns ratio to the coil L1) is given in the specification, together with numerical examples for certain specified ranges of frequency.

The General Electric Co., Ltd.; D. W. Berry; and R. Mawson. Application date, June 8th, 1945. No. 599149.

Waveguide Radiators

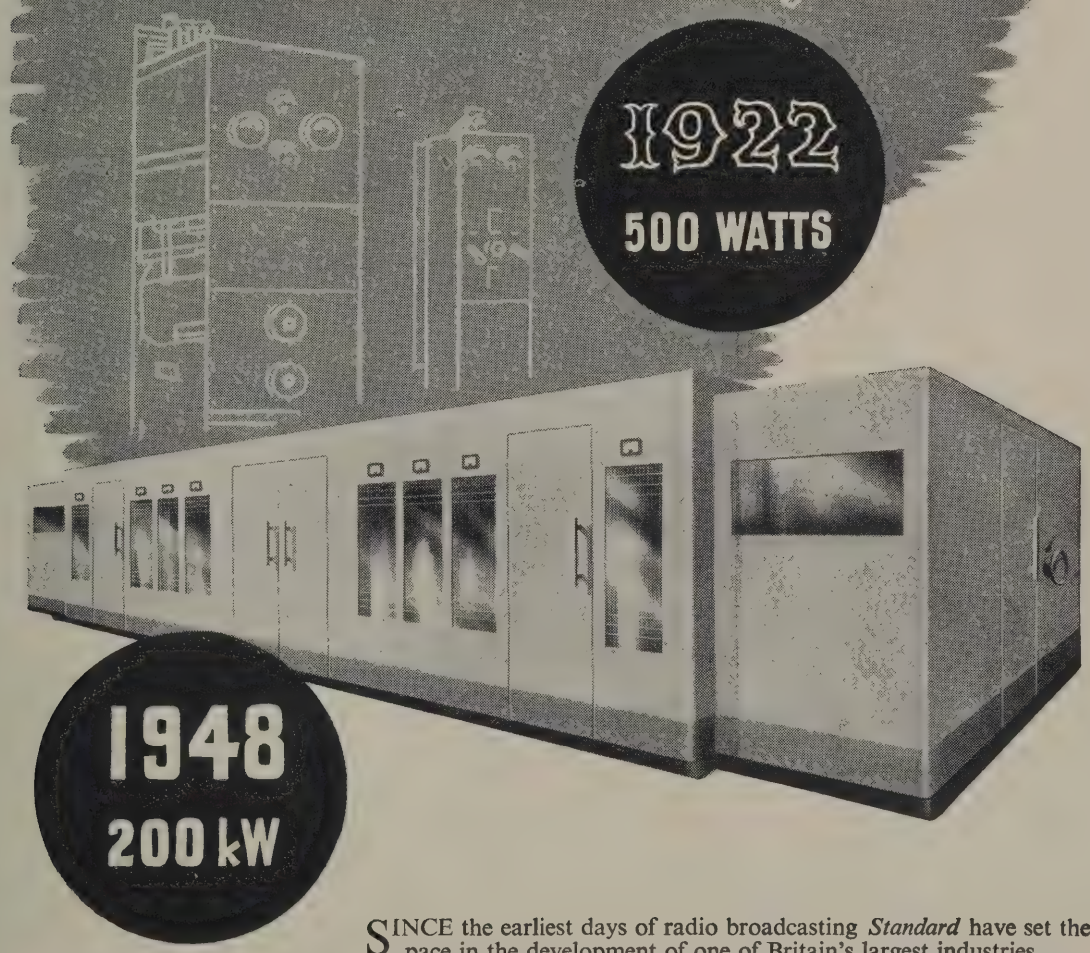
A RECTANGULAR waveguide with suitably flared ends is commonly used for the directional transmission and reception of short-wave signals, particularly in combination with a parabolic reflector or mirror. In practice it is found that a certain amount of energy is reflected back from the mouth of the flare or horn. This sets up standing waves, which give rise to mis-matching and other losses.

According to the invention, one or more reactive elements, preferably in the form of narrow metal strips or bars, are placed across the aperture of the horn, close to the mouth and in contact with selected sides. These act as variable reactances and can be adjusted to provide the terminating load or surge impedance required to prevent reflection losses.

E. Wild and C. S. Wright. Application date October 10th, 1945. No. 601280.

The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 2 - each.

Standard Radio
Ahead of Radio Progress



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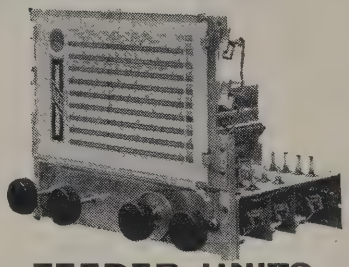

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(b) 250-0-250 v. 60 mA. 4 v. 4 A., 4 v. 2 A. ..	15 6
(c) 250-0-250 v. 80 mA. 0/4/6.3 v. 4 A. C.T., 0/4/5 v. 2 A.	18 0
(d) 300-0-300 v. 80 mA. 0/4/6.3 v. 4 A. C.T., 0/4/5 v. 2 A.	18 0
(e) 350-0-350 v. 80 mA. 0/4/6.3 v. 4 A. C.T., 0/4/5 v. 2 A.	18 0
(f) 250-0-250 v. 100 mA. 0/4/6.3 v. 4 A. C.T., 0/4/5 v. 2 A.	21 0
(g) 300-0-300 v. 100 mA. 0/4/6.3 v. 4 A. C.T., 0/4/5 v. 2 A.	22 0
(h) 350-0-350 v. 100 mA. 0/4/6.3 v. 4 A. C.T., 0/4/5 v. 2 A.	23 0
(i) 350-0-350 v. 150 mA. 0/4/6.3 v. 6 A. C.T., 0/4/5 v. 3 A.	38 0
(j) 425-0-425 v. 180 mA. 6.3 v. 4 A. C.T., 6.3 v. 4 A. C.T., 5 v. 3 A.	43 6
(k) 425-0-425 v. 180 mA. 4 v. 8 A. C.T., 4 v. 4 A. C.T., 4 v. 4 A:	43 6
(l) 425-0-425 v. 180 mA. 6.3 v. 4 A. C.T. 4 v. 2 A. C.T., 4 v. 2 A. C.T., 5 v. 3 A.	46 0

Types (i) (j) (l) are fully shrouded upright type.

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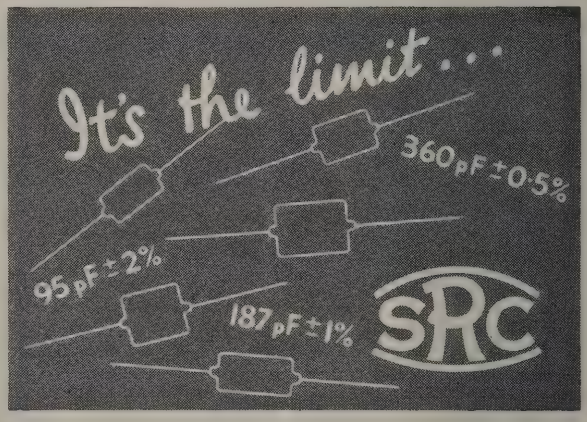

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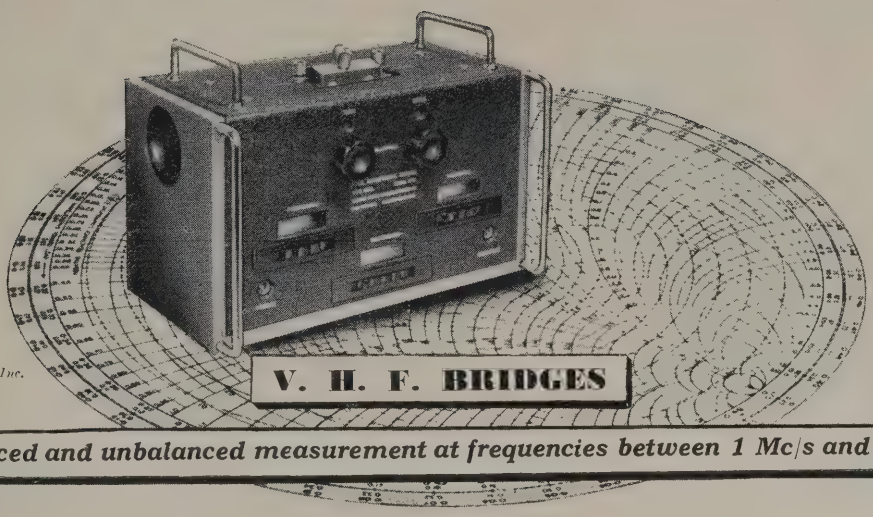

Diagram by courtesy of McGraw Hill Pub'g. Co. Inc.

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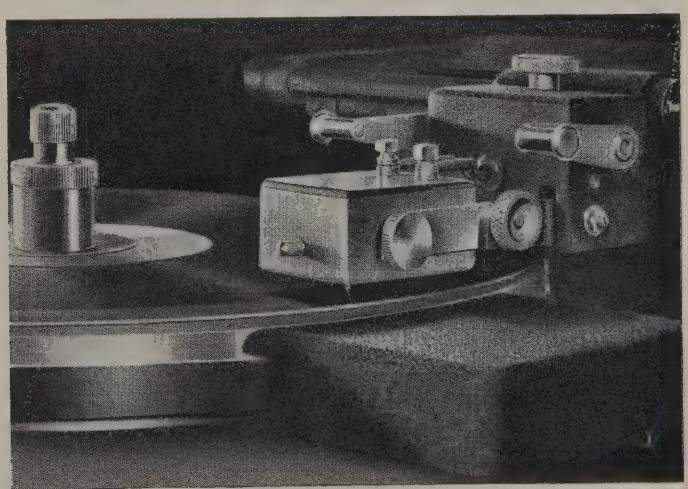

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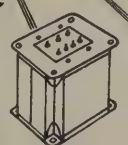

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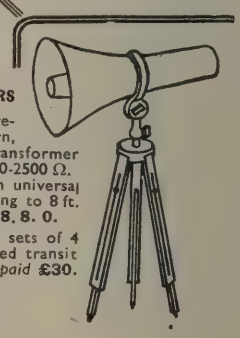

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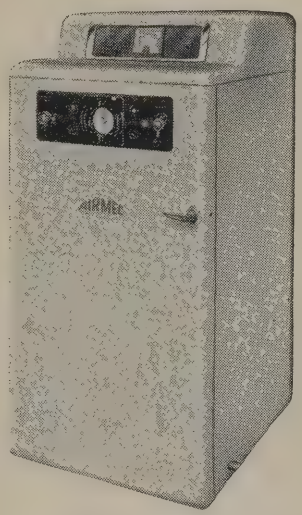

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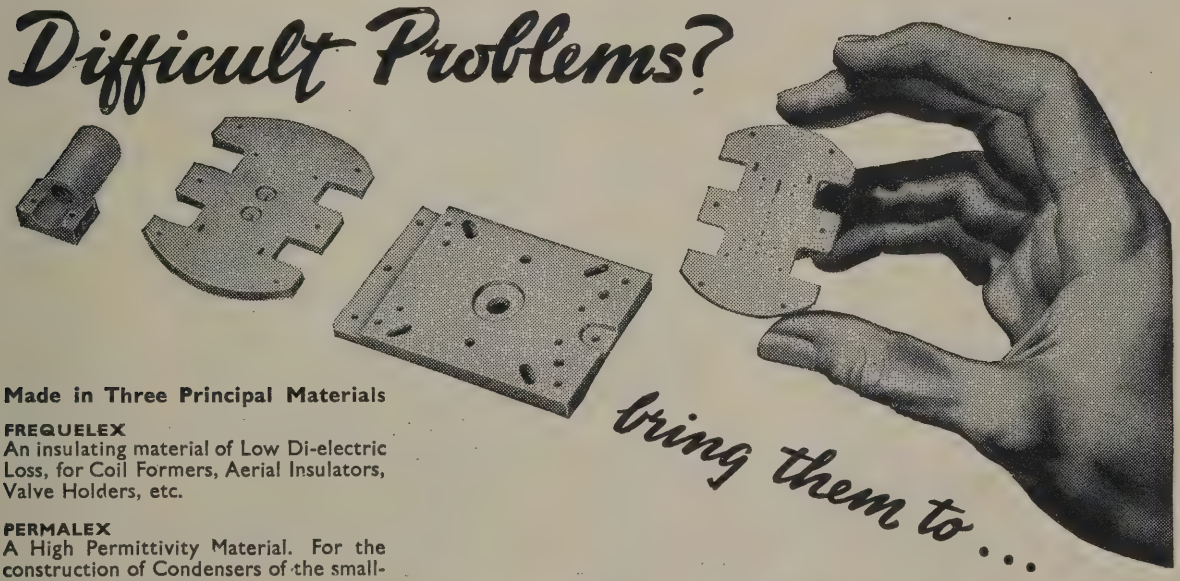

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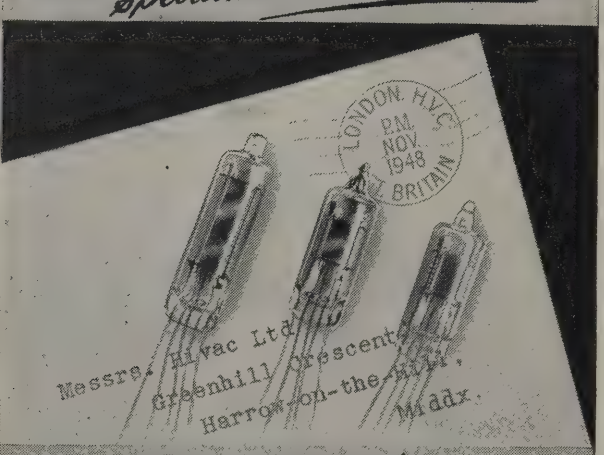

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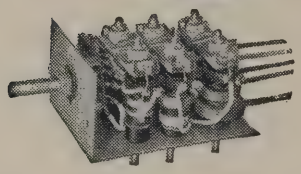

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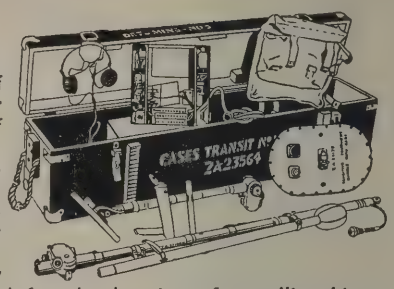

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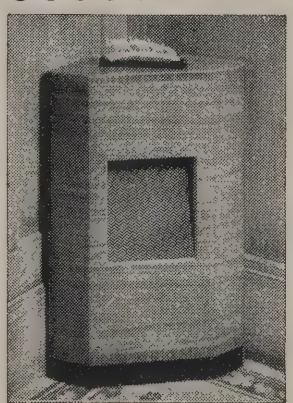

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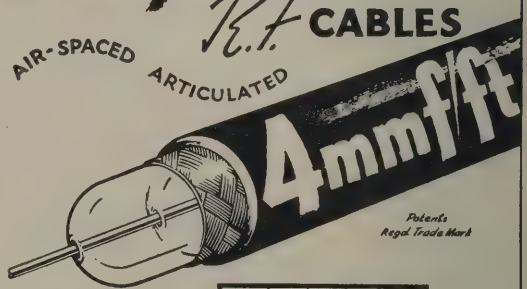

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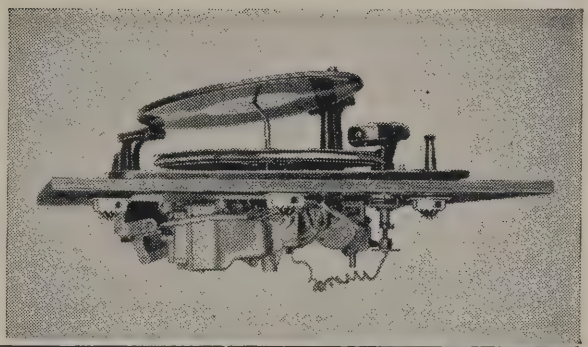

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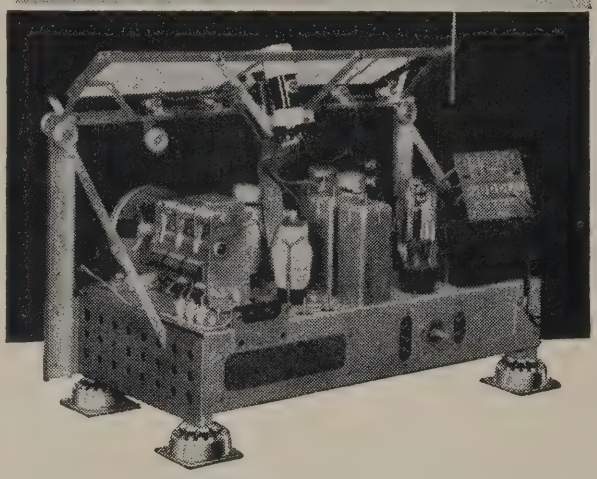

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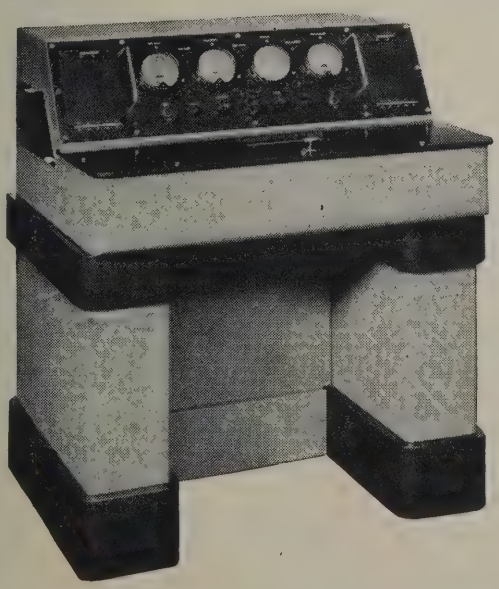

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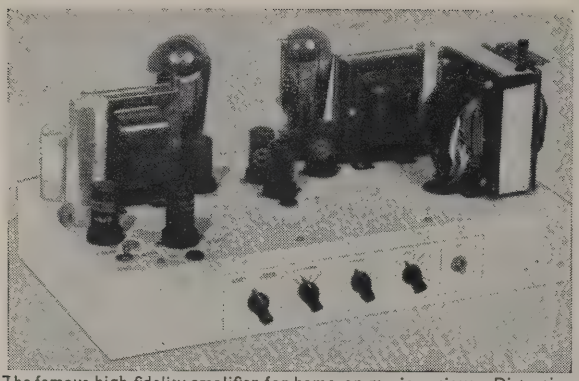

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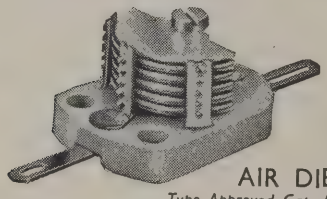

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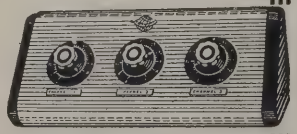

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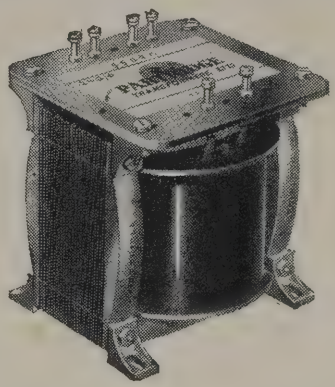
MASON'S (W.W.), Wivenhoe, nr. Colchester.—5- and 10-waveband gram chassis, covering 3-60mc/s and 150-1,500kc/s, feeder units with r.f. stage and flywheel tuning, radio kits, auto-stop and 8 mixed changer units, amplifiers 5-500watts, Eddystone and Denco equipment and components, complete television chassis for London or Birmigham transmission and constructors' kits for London area from £45; s.a.e. for details or send 9d. now for our illustrated 54-page catalogue. [2020

THE now famous Williamson amplifier as manufactured by Radio Trades Manufacturing Co. (Ealing), Ltd., is definitely acknowledged as the world's finest amplifier at a reasonable price (vide numerous testimonials from famous critics), built to specification from real quality components on extra heavy gauge chassis with cover, this amplifier constitutes the finest product in the trade to-day; if you are genuinely searching for quality reproduction your search is ended as we can supply what you want; price complete with cover £27/10; gram. motors, tuners, pre-amplifiers, speakers and pick-ups supplied; trade enquiries invited.—Write or call, R.T.M.C. (Ealing), Ltd., Laurel House, 141, Little Ealing Lane, W.5. Eal. 6962. [2025

Partridge News



TOLWORTH FACTORY

Our new modern transformer factory and laboratory are now in operation and equipped with up-to-date machinery for the manufacture and testing of quality components. Increased facilities have enabled us to improve our service. As well as having 100 different types of transformers and chokes available from stock, we can wind to specification within 14-28 days depending on the quantity and types involved. Our range has been increased to cover power transformers up to 25 K.V.A. and we shall be pleased to send our catalogue and stock list upon request.

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LONDON SALES OFFICE

For the benefit of our many friends we have made arrangements for the immediate supply from stock of small quantities of our standard components These can be collected from our address at King's Buildings, Dean Stanley Street, Millbank, Westminster, S.W.1. Tel.: Abbey 2244. (250 yards from Big Ben). Hours: 10 a.m.-1.0 p.m. and 2-5.30. p.m. (Mondays to Fridays only). Kindly note this address is for stock sales only.

★ ★ ★ ★ ★

NEW ADDRESS

We should like to draw attention to our new address at Tolworth (situated just off the Kingston By-pass). This is now our sole factory. Callers and all correspondence should go to this address :—

PARTRIDGE TRANSFORMERS LTD

Roebuck Road, Tolworth, Surrey

BC.348 American communication receivers, new, £18/10; R.28 American 10 valve receivers, new, 45/-; BC.453 American 6 valve receivers, 35/-; all carriage paid.—G. Lawrence & Co., 3, Slater Place, Liverpool, 1. [2489

UNIVERSAL ELECTRONIC PRODUCTS, 36, Marylebone High St., W.1. Welbeck 4058. Specialists in the design and manufacture of high grade fidelity gramophone reproducers and radio units. If you are interested in obtaining the finest possible reproduction from recorded music we invite you to hear our equipment demonstrated in conjunction with the Wilkins and Wright coil pick-up and the Wharfedale corner cabinet speaker. We will gladly give you a quotation for the conversion of your existing radio gramophone into a first-class reproducing instrument, or for the design and construction of equipment to your own special requirements. Write for descriptive leaflets of our range of fidelity amplifiers and radio tuning units.

GOODSELL, Ltd., 40, Gardner St., Brighton, 1, Sussex.—The finest range of amplifiers available; to Williamson's specification, K.T.66 at £22; P.X.4 version at £17/17/6; and without a doubt the finest of all, the P.X.25 amplifier with two chassis and two power packs for 500 and 275 volts h.t. at £28/7, carriage extra; all on black crackle steel chassis, K.T.66 and P.X.4, 14×10×3, P.X.25, two chassis, 12½×8½×2½, paper condensers fitted on h.t. except in P.X.4, which has paper for reservoir Partridge transformers as standard, all valves B.V.A., beautifully finished with enclosed double fuse holder and recessed mains input; for use with above or any good amplifier, our tone control unit, separate 6-way treble and bass control, boost and cut available by turning a switch, 2 valves, L.63s at £6, or high gain with E.F.37s at £6/6; also quality feeders, including a specially designed superhet (2-band) for fidelity reception, variable selectivity, distortionless detector, etc. Components for Williamson: Partridge mains transformer, 57/-; chokes, 21/6 and 31/6; output transformer, £5; R.T.S. output, tropical finish, to specification, £3/7/6. [2573

RECEIVERS, AMPLIFIERS—SECOND-HAND

HALLICRAFT Skyrider, perfect condition, two speakers.—Box 2610. [2302

R.1116 8v battery superhet, £7; MCR.1, £7, both as new.—Box 2634. [2332

G. W. SMITH & Co. (RADIO), Ltd., offers the following, sound and perfect:—

TELEVISION.—Ex-R.A.F. R. 585 receivers, brand new in sealed boxes, a complete 45mcs T/V strip, using 5 t.r.f. stages (E.F.50s), 1 diode stage (E.A.50) and video stage (E.F.50). In addition to the above there are some 17 other valves, including E.F.50, VR.54, 55, 56, 65, together with dozens of condensers and resistors all of useful values, supplied complete with circuit, £5/10; ex-R.A.F. type 1355 receivers, for use with types 24, 25, 26 and 27 U.H.F. units, complete with valves also suitable for T/V construction, 32/6; ex-Admiralty responser units, type W 4790B, brand new in sealed boxes complete with valves, very little modification needed for a complete vision and sound pack, 52/6 each; television Polystrene ½in slugged coil formers with dust cores, 6d each, 4/9 dozen; wavemeters, ex-R.A.F. type W. 1191, brand new in sealed boxes, complete with crystal and spare set of valves, coverage 100kc-20mcs, can be used as signal generator, £5/10 each; crystal multipliers, brand new in sealed boxes with 2 807 valves, 39/6 each; meters, 0-20v a.c., 7/6; 0-20 amp a.c., 7/6; 0-0.5amp thermo, 3/6; 0-1.5amp thermo, 7/6; 0-3amp thermo, 4/-; 0-6amp thermo, 4/-; 0-5amp d.c., 7/6; 0-20v d.c., 4/3; 0-5ma, 4/9 each; 2-speed s/m dials, as fitted to the 27 U.H.F. units, 5/- each. Special offer: Ex-R.A.F. type 39, aerial coupling units, complete with 0-3amp and 0-6amp thermo meters, also 100-watt dummy aerial, brand new, 7/6 each; Westectors, type W.6, 6d each; 12-volt starter relays, 3/6 each; constant voltage transformers, 190-260-volt input, 230-volt output at 100-watt, 60-watt auto transformers, 17/6 each; 4mfd Mansbridge condensers, 1,000-volt, 2/9 each; diode valve holders, 2/9 dozen; 200ma 5 henry l.f. chokes, 4/6 each.
G. W. SMITH & Co. (RADIO), Ltd., 3, Lisle St., London, W.C.2. Tel. Gerrard 8204. Open all day Saturday. [2576

RCA, AR77, in perfect condition; £28/10.—R.S.S., Ltd., 68a, Park Rd., N.8. Mou. 5533.

FOR sale "Hallicrafters" S20R Sky Champion communications receiver; what offers?—Box 2922. [2398

AR88, 54-32mcs, rack mounting, perfect working order. £40; buyer collects.—Burchill, 75, Green St., London, E.7. [2449

INVICTA televisor, model TL5, completely overhauled by makers, condition as new, £35 or nearest offer.—Box 2615. [2308

HAMMARLUND Super Pro, 17-tube "S" meter, crystal gate, excellent condition; requires separate pack.—Box 2931. [2440

WIRELESS World 2 R.F. 3 valve quality tuner for use with quality amplifier; £6/10, including valves; new and unused.—Box 1584.

24-hr. television (not Radar conversion) uses V.C.R.97 tube; send large s.a.e.—T-H Products, 92, Leathwaite Rd., S.W.11. Bat. 4889. [2472

HALLICRAFTER S27 V.H.F. receiver, covering 144 meg band, Sky Champion S20; first reasonable offer; wanted, AR88, cash, or exchange for both above GW3KY.—"Brixton Mount," Holyhead. [2352

REALISATION OF PERFORMANCE

Last month we stressed the importance of good service relations with our customers. Now a word as to the equipment itself. We used to joke that we were the only firm that did not advertise perfect reproduction, but the fact remains that we have always been precisely accurate as to what we say in our advertisements about our products. We make no claim to "perfect reproduction" because such a claim is pure nonsense. Neither we nor any one else will ever be able to give perfect reproduction of musical sounds, so we content ourselves with providing the maximum possible musical enjoyment from radio and records.

The knowledge of designing non-distorting radios and amplifiers is widespread because the theory and practice of the science admits of exact scientific treatment. But the number of people who can design a non-distorting speaker is very small because more than science is involved. There has to be added a something which is really a fine art, and the practice of that art must not be hampered by having to design acceptable speakers for equipment which, through economic considerations, introduces distortion. It requires a great deal of knowledge to design a very good speaker and a great deal of courage to refuse to supply them to makers of equipment with an inferior performance. But this is how the Hartley-Turner 215 has made its name, as did its pre-war brothers.

We have accumulated enough evidence from all over the world to satisfy us that in the Model 215 we have produced a more musically satisfying speaker than any other **at any price,** and your first step towards realisation of performance is to buy it. The few that have appeared in the small advertisements of this journal have been eagerly snapped up and give unalloyed satisfaction. That these advertisements appeared at all is merely evidence that no man can please everyone. But we do please those who do want freedom from distortion. Send for our free literature to-day, and above all read "New Notes in Radio," a half-crown guide to the whole subject of high-fidelity which will clear up most of the problems that are worrying you. Like our speaker it gives, we are told, the truth without distortion.

The HARTLEY-TURNER SPEAKER
£9 plus 1/6d. post and insurance. 5/- deposit on returnable carton.

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RIVerside 7387

TELEVISOR for sale, comprising modified 3132 Rx, A6 indicator. 50 cycle power pack, all working order.—Offers to Box 3103, or Tel. Eltham 7361. [2463

NATIONAL HRO, 50 k/c-30 m/c, in 9 bands, 230v power pack, all in very good condition; £32.—Callow, Ridgeway House, A.E.R.E., nr. Didcot, Berks. [2351

CHALLENGER 19 5-2,000 metres, 30 watts. Magnavox 66, baffle, pick-up and motor separate box; £35 or offer.—Allen, 9, Eaton Place, S.W.1. Slo. 4401. [2343

FOR sale, 7-valve 8 waveband radio unit as used in the Decola, perfect condition, very little used; bought August, 1948; £35.—Millard, 44, London Rd., Baldock, Herts. [2482

PYE D16T television receiver, £45; Murphy television receiver, model V114, £50; both in excellent condition.—R. W. Clitheroe, 42, South Rd., Saffron Walden, Essex. [2420

HALLICRAFTER SX28, 7-550m, 15 valves, excellent condition, £40; spare set new valves, £7; matched speaker £4, or nearest offer.—53, Aston Lane, Birmingham, 20. [2313

PORTABLE amplifiers, 12watt a.c. gram mike inputs, separate bass, treble controls, £10; 3watt a.c./d.c. speaker included same cabinet, high fidelity, £5/10; London area.—Box 2393.

GOING abroad, no reasonable offer for lot or individual items refused, RX1155 and BC348 mod. mains and pen. output, 5 0-1 m/ammeters, 5in m/e and 8in p/m speakers with t/former, 200 various resistors and condensers. —Box 3180. [2525

M.R.C.I. miniature communications receiver, 5-valve superhet, covering 2,000-10 metres, with headphones and power pack, for any a.c. or d.c. mains; just overhauled; £8 or nearest offer.—Horsfield, Malt House, Willersey Broadway, Worcestershire. [2423

A.R.88 receivers, offers invited; 1155 receivers, new delivery, £8, carr. paid; 1124D receivers, with 6 universal valves, diagram and gen for television adaptability, to clear 18/6, carr. paid; 1224A receivers, new, £4/10.—J. Rae, 39, Penn Rd., Wolverhampton. [2547

BRAND new condition R.C.A. amplifiers for 230v a.c. operation, magnificent ventilated steel case, finished grey wrinkle enamel, valve line up: 6J7-6J7-6J7-6J7-6L6-6L6-5U4G, a fine quality product; price, carr. paid, with circuits, £16/5, or less valves, £13/15.—Lawrences, 61, Byrom St., Liverpool. Cen. 4430. [2386

H.R.O. Senior, coils, bandspreads, Xtal, Bendix p.p., H.R.O. rack fitted coil container, excellent condition, only s-meter missing (obtainable), nearest £35; 8 H.R.O. coils, set 100kc-30mc, 3.5, 14, 28mc bandspread, nearest £20 or individual offers; 7-14mc coil, 50/-.—The Amateurs Den, 181, Lake Rd., Portsmouth. [2551

BARTONS high gain 25-watt amplifiers, output impedance 2-15 ohms with two high gain mike inputs with transformer to match M.C. mike, etc., also two low gain inputs, complete with meter, switched to check all valves, mains input 200-250v 50cy, price £12; also large power amplifiers up to 460 watts.—Please send for list to: Barton, 41, Bedminster Down Rd., Bristol, 3.

RELIABLE quality P.A. ampl., 56 watts, sep. P.U. and mike valves, 5 stages A.F., treb. and bass lifts, 4 DA30s, in class A, twin L.S. transfs., mult. taps meter and jacks, exceptional smoothing, hum inaudible, adeq. gain Xtal mikes, sep. power unit, 620v at 300 ma, in trolley, usable separately semi-port, with motor board, Xtal, P.U., B.T.H. motor and radio unit, adj. whis. filter; used only 50 hrs.; worth £85; what offers?—Archway 1016. [2322

FOR sale, due to move, carefully concealed in genuine antique pieces, McMurdo-Silver Masterpiece V, record changer, and single-disc player with "Coil" pick-up; receiver and changer built into 18th century commode, with doors to tuning unit and drawer for changer; single disc player in 18th century workbox; cinema type speaker in Regency cupboard with two doors, 5 wavebands, variable selectivity, B.F.O. treble and bass controls, 30watt P.P. output stages, two-stage pre-amplifier for coil P.U., with variable scratch filter, £175.—Flat 5, Greenacres, Groby Rd., Altrincham. Alt. 3596.

TELEVISION.—Ex-Govt. radar receivers, as brand new in makers' cartons, no alterations required, for use as vision receiver section in television set, contains 4 EF50 R.F. stages, 1 EA50 detector, 1 807, meter jack and selector switch, 70ohm co-axial input, supplied tuned to 45 mc/s, bandwidth 4 mc/s, and is equivalent to corresponding section in many commercial sets; 75/- inc. post. and pkng., circuit diagram and instructions for use as vision receiver and for obtaining sound from same chassis; post orders only, satisfaction guaranteed.—Hanstead Radio, 38, Elsham Rd., London, W.14. [2490

R.1585 Western Electric U.H.F. miniature receivers, 234-258mc/s, 12 valves, 3-6AK5, 7-9001, EBC33, 12A6, 3 R.F. stages with ganged tuner and 12 switched osc. coils giving 6-spot frequencies, 2 I.F. BFO amplified A.V.C. det. and power output, equipment offered comprises 3 units, receiver with 11 valves, rack mounting for receiver with A.V.C. unit and valve, and a remote control unit; power unit and connecting cables are not available; receiver size, 11in×6in×5in; condition unused and as new in manufacturer's cartons; the 3 units complete with valves as above, £4/10, plus 5/- carr. and 10/- dep. on crate (returnable); circuit diagrams, 2/6 ea; a s.a.e. will bring you a 10-page list of other surplus bargains.—H. English, Rayleigh Rd., Hutton, Brentwood, Essex. [2231

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SPECIAL OFFER. FOUR GANG 300 pf. **3/6** each.

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All good makes. Recent manufacture. Tubular. Wire ends. 8 mfd. 500 v. **3/9.** 50 mfd. 12 v., **1/3.**

Metal tubular. Tag ends. 25 mfd. 25 v., **1/6.**

Vertical can. 8-8 mfd. 450 v., **4/9.** 8-16 mfd. 450 v., **5/3.** 16 mfd. 350 v., **2/9.** 32 mfd. 350 v., **3/-.** 32 mfd. 275 v., **2/9.**
All vertical can types supplied with clip.

METAL CASED TUBULAR (American).
.01 mfd. 1000 v., .25 mfd. 350 v., **6d.** .5 **/6** doz. .02 mfd. 750 v., **4d.**, **3/6** doz. .1 mfd. 350 v., **4d.**, **3/6** doz.

CARDBOARD TUBULAR.
.1 mfd. 350 v., **4d.**, **3/3** doz. Midget .1 mfd. 150 v., .05 mfd. 350 v., **6d.**, **5/6** doz.

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Midget 20, 80 and 200 pf., **3d.**, **2/9** doz. .001 mfd., American, **4d.**, **3/6** doz. 200 and 250 pf., 4000 pf., **4d.**, **3/6** doz.

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M. WATTS & Co.
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Weybridge, Surrey

Telephone: Weybridge 2542.

PORTABLE mains transmitter-receiver, 4in×8in×10½in, 2 wavebands, 2 to 8 mc, with valves 6L6, 5Z4, 6SC7, 6K8, 6J7, £5 only.—B. E. R., 39, Brighton Rd., Birmingham. [2416

LOCAL station radio feeder unit, £5/5; 6-watt high fidelity push-pull amplifier, £12/12; 12-watt model, £18/18; all complete with valves; technical data sheets on request.—E.A.D., 13, Bence Lane, Darton, Barnsley. [2455

NEW LOUDSPEAKERS

WRITE for details of the new Flexicone conversion which considerably improves reproduction of speech and music to existing speakers.—Looker's Quality Radio, 106, Davidson Rd., East Croydon. [1923

HIGH quality, precision-built speakers. Ticonal magnets, detachable diaphragms, die-cast chassis, twin cone.—Broadcast & Acoustic Equipment Co., Ltd., Broadcast House, Tombland, Norwich 26970. [6435

TRIDEM 12 corner cabinet loudspeaker set a new listening standard, special 12in unit gives response 40-15,000 cps hand-made cabinet.—F.S.R., Ltd., 87a, Upper Richmond Rd., East Putney, S.W.15. [2354

LOUDSPEAKERS, SECOND-HAND

BAKER 18in p.m. 15ohm, as new; 5gns.—Tel. Chiswick 5975, after 7 p.m. [2305

VOIGT light coil twin, field rectifier, O.P.T.; £27.—4, Baldwins Park, Bexley.

VITAVOX K12/20, £6; Magnavox 66, 230v, a.c., £5.—113, Hazel Rd., Huyton, Lancs.

LOWTHER-VOIGT p.m. light coil twin unit, as brand new, £24.—Hewson, 28, Signhills Ave., Cleethorpes. [2493

B.E.A.C. infinite baffle with Hi-fi speaker, £12; Hartley-Turner 215, £7, or offers.—Haskell, 8, Ash Grove, Guildford. [2330

BAKER 18in p.m., 15ohm, in closed 1in thick elmwood cabinet, 26in×26in×18in; £11.—111, Rupert Rd., Roby, Liverpool. [2360

FOR sale, Voigt reflector corner horn with twin diaphragm unit and a.c. power unit for same.—Offers by letter to 34, Florence Rd., Sutton Coldfield. [2456

BAKER super quality 12in triple cone speaker with Ticonal magnet, complete with infinite baffle cabinet in veneered walnut, 15ohms speech coil; £7/10; new and unused, half original price.—Box 1383. [1764

EX-U.S. Govt. P.A. reflex horn pressure loudspeakers, with built-in transformer tapped 250, 500, 1000, 2500ohms, £5/10 each; four in transit case, £20.—M. A. Weston, Harman's Cross, Corfe Castle, Dorset. [2505

VOIGT corner horn, special model, in natural light oak veneer, with horn mouth cover; twin light-coil diaphragm, perfect, £55 or offers; another, in dark walnut, French polished, £40.—Brewer, Bethcar St., Ebbw Vale. [2098

HARTLEY-TURNER 215, £7; ditto, Duode de luxe, £6/10; Goodman 12in p.m., £5/10; Connoisseur p.u., 70/-; Telefunken 1001 p.u. and motor £10; a.c./d.c. meter, £4; or nearest; all as new.—Gardner, 41, Miller Ave., Grimsby.

TWO P.A. L.S.s, each takes 50 watts, BAEL P.A./12/D, inf. baffle expon. corner horns with bass chamber; each uniform top distrib. over 90 deg. arc, suitable halls or open air; high qual. Vitavox K12/20 units, 15ohm perm mak flux lens, 17,000L,acoust. eff. 35%; 42×22×16½in high, 16-yd cables, exc. condition, cost £23 each, sold singly; also two L.S.s, similar above, but IBCD; "Hi-Fi" PM/15 units, 30 watts each, 25% eff.; suit home and halls, or open air (slight addition), 26×20×16in, 18-yd cables, exc. cond.; cost £15/5 each; what offers?—Archway 1016. [2323

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VALVES! Valves! Valves!—Almost every type of valve in stock; why wait for valves? All of our stocks are brand new at makers' list prices, no ex-Government stock; send no money, we will send c.o.d. return of post.—Hansard, Market Place, Spalding. [2249

DYNAMOS, MOTORS, ETC.

GENUINE plug-on dynamotors for BC453, etc, 14v in, 230v out, 12/6.—Lawrences, 61, Byrom St., Liverpool. Cen. 4430. [2387

E.D.C.C. rotary converter, 110 d.c./230 a.c. 180w with filter and silencing cabinet; perfect mechanically electrically; also Garrard universal a.c./d.c. motor and turntable, little use.—Box 2928.

BATTERY chargers, 4 models, 2-6-12v, 1-2-4 amps D.C.; any mains voltage; also larger types, special transformers, chokes, test gear, interior car heaters, etc.—The Banner Electric Co., Ltd., Hoddesdon, Herts. [2212

ELECTRIC motors.—Our famous range of motors again available from stock; example, ¼hp single-phase, 200-250v, 1,400 rpm, from £6/16/6; send for lists.—John Steel, Bingley, Yorks. Tel. 1066 (4 lines). [9968

NEW Onan pet. generators, 12/15v 600watt, self-starter, air-cooled 4-stroke, voltage reg. auto cut-out, ammeter, complete with tools, spares and instruction book, £24, plus carriage; chargers; H.D. 50v, 50a, 3-cct. m/c meter, control panel switches and fuses, input 200/250 1ph or 440/3/50, £20 only, plus carr; pet. gens. 12/15v, 360watt Alco Lyons 4-stroke, new or hard y used, ammeter, etc., £16/10, carr. free; others, 200/250 in 24v, 25a, in steel case with control panel m/c meters, rheos, fuses, etc., £12, plus carr.; 6/24v at 12a, with meters, fuses, etc., in steel case, £10, plus carr; rectifying units, input 230/1/50, output 220v, 3a, d.c., metal rects., £8/10, plus carr.—Pearce, 66, Gt. Percy St., London, W.C.1 (near Angel). See also under components. [2534

D.C. to A.C. motor alternators, 200-250 volts D.C. input, 200-250 volts 50 cyc, 1 ph A.C. output at 200 watts, ball bearings, new, £12/10 each; also new rotary converters with special smoothing equipment up to 500 watts output for television, radiograms, etc.; prices on application.—Johnson Engineering, 319, Kennington Rd., London, S.E.11. Reliance 1412-3. [2191

TEST EQUIPMENT

COSSOR D.B. Osc'pe with instructions, new; £35.—Box 2640. [2366

R.C. coupled audio osc., 5 steps, 20c/s-40kc/s; £15.—Box 2642. [2368

AVO Minor, universal, as new; £6.—16, Banbury Dr., W. Timperley, Cheshire. [2499

DUMONT 'scope, 241, as new 5in tube, £20 or offer; also Wee Megger, £5.—Box 3241.

COSSOR 339 oscillograph, reconditioned as new, at present fitted single beam tube 3¼in, £27; (Hants).—Box 3106. [2468

FOR sale as new, G.E.C. Miniscope, £17; Taylor signal tracer, £12.—Surtees, 78, High St., Felling, Gateshead, 10. [2427

MICROAMPMETERS, 0-100, FSD, blank scale, plug-in, new style, 2½in; 17/6.—A. Stansfield, 62, Aireworth Terrace, Keighley.

SALE, test equipment, Avometers, Avominors, testers, signal generators, big reductions; list s.a.e.—Young, 134, Old Shoreham Rd., Southwick, Sussex. [1931

AUDIO signal generator, model 205AG, by Hewlett Packard, Dumont, oscillograph type 168, Corros and ultra oscilloscopes; cheap. Write, B. E. R., 39, Brighton Rd., Birmingham.

UNUSED Partridge oscilloscope transformers combined E.H.T., H.T. & L.T. double screened, suitable for W.W. Oscilloscope, snip 45/-; Douglas power driven wave winder, sacrifice, £35.—Box 3108. [2474

TAYLOR 45A valve tester, £18; E. Edgecombe all-purpose tester, £11, both as new; Shaftesbury model SC portable amplifier, complete outfit, nearest £15.—Bartley, 64, Stour Rd., Christchurch, Hants. [2462

MARCONI TF144G standard sig. gen, £59; Cossor 339A d.b. oscilloscope, £29; Cossor 343 ganging oscillator, £25; near offers considered, all ex. cond.—The Amateurs Den, 181, Lake Rd., Portsmouth. [2552

MIDGET battery audio modulated signal generators, directly calibrated frequency-metres, 6 ranges, 100kc-30mc, 3,000-10m, new, ideal radio servicing; £5/10 (plus 2/6).—BM/AMSP, London, W.C.1. [2333

ONE Avo valve tester, complete with latest panel and instruction booklet; one Mullard test bridge; one 18in Baker auditorium P.M. speaker, triple cone, as new and unused; best offer secures.—Box 2930. [2431

HICKOK multi-range test set a.c./d.c., 1,000-ohm p.v. inc. inf-resist V/M, Avo valve tester with 2 panels, Solar cond/resist bridge, Weston and Philco oscillators, etc.; all for immediate sale; best offers secure.—Box 2612. [2304

SERVICE equipment.—Cossor frequency modulated ganging oscillator, model 3343; Cossor double beam oscillograph, model 3339; Cossor a.c. impedance bridge, model 3389, and equipment rack; £55.—Superb Radio Co., 424, Hertford Rd., Edmonton, N.9. Tel. How. 2059. [2337

FOR sale, Western Electric TS-34/AP oscilloscope, 2in tube (6AK5, 6AG7, 6SL7-GT, 6AC7/1852, 6SN7-GT, 5Z3-GT/G, 6X5-GT/G valves), instruction book and fibre carrying case, 29in×9⅝in×10in, included, total weight 46lb; £40 or offer.—Indoe, 2, Lime Grove Gardens, Pulteney Rd., Bath. [2421

FIND the fault with our high efficiency signal tracer; measure up with our multimeter; retrim with our signal generator, oscilloscope and wobbulator; whilst the big set's out of action, listen on our personal portable; Nuplans—each plan 2/6 from E.N.B., Whinnie Knowe, Sennen, Cornwall. S.a.e. list. [2487

SIGNAL generators by Marconi Instruments, type 144g, as new, £75 each; audio frequency oscillators by B.S.R., type L050a, new and in makers' carton, £22 each; all unused ex-Govt. surplus; also voltmeters, ammeters, etc.; send for lists.—Oak Instruments, 195, Coppermill Lane, London, E.17. Larkswood 6122. [2569

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COMBINATION portable valve tester and multi-range meters by famous U.S.A. makers, ranges d.c. volts, 0-10, 50, 250, 500, 1,000 at 10,000 Ω/v; a.c. vlts ditto at 2,000 Ω/v; d.c. ma 0-1, 10, 50, 250; 4 resistance ranges reading 0.1 Ω to 15 meg Ω; capacity 0.01 to 10uF tests over 1,000 U.S.A. valves, black crackle case with carrying handle, each instrument tested and guaranteed, £17/10, carr. paid; U.S.A. make output meters, 5 ranges, 1.5 to 150v a.c., in small bakelite case, £4/17/6, post free.

FRITH RADIOCRAFT, Ltd., 69-71, Churchgate, Leicester. [2530

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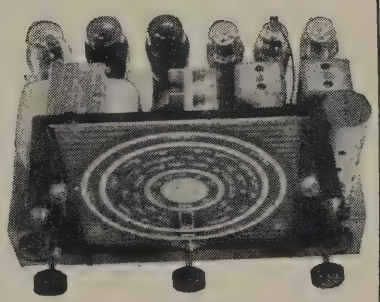

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GRAMOPHONE AND SOUND EQUIPMENT

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ROTHERMEL PR2S sound-cell microphone, lead; £4.—Selby, 207, Blackfriars Rd., S.E.1.

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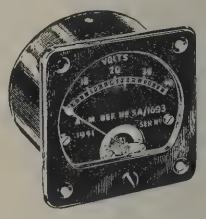

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E.H.T. transformers, mains transformers and chokes for cathode-ray oscilloscope as per "W. World," Dec., 1948; delivery ex-stock.—Metropolitan Radio Service Company, 1021, Finchley Rd., N.W.11. Tel. Speedwell 3000.

BATTERY eliminators, manufacturer's surplus, input 200-250v a.c., output 120v 20ma, smoothed (no tappings), and 2v ½ amp for accumulator, brand new, guaranteed 6 months; post free, 39/6.—C. Brinkman & Co., Chitty St., London, W.1. [2494

LITTLEWOODS.—Electronic Engineering televisor, all components in stock, 3rd edition book reprinted Oct., 1948, containing latest revisions and modifications, 2/8 post free.—G. Henson Littlewood & Co., 27, Ballards Lane, Finchley, N.3. Fin. 3060. [2563

THE pioneer manufacturers of the Williamson amplifier offer finest quality set of transformers and chokes at £8/15, inc. car.; fully shrouded, beautifully made and guaranteed.—R.T.M.C. Ltd., 141, Little Ealing Lane, W.5. (See advert. under Amplifiers.) [2370

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AMAZING bargain, 9/6, complete kit parts for 3 W.B. superhet coil pack, including Yaxley type, coils, chassis, trimmers, etc., I.F.T.s 465, 7/6 pr.; amphenol octal, 4½d; send for cheapest list in England.—Sussex Electronics, Ltd., (G) Bevendean, Brighton. Tel. 4446.

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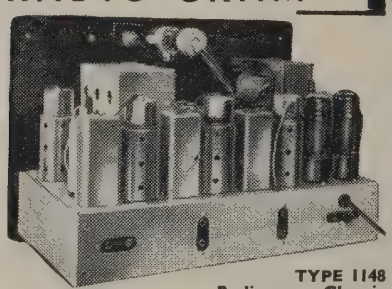

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UNUSED Sound Sales mains transformer, model 500/250, primary 10-0-200-220-240 at 40/100 cycles; H.T secondary, 500-0-500v. 250 mA; L.T. windings, 2-0-2 at 3.75 amps; 2-0-2 at 3.0 amps; 2-0-2 at 3.0 amps; 2-0-2 at 2.0 amps; 2-0-2 at 2.0 amps; price £6 or near offer.—Standard, Peene House Cottages, Newington, Folkestone. [2429

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SET of four coils, long, medium and short, 4-pole 4-way switch, pair 465kc standard iron cored, ifs, twin gang condenser and circuit, 13/6; Rola 5-inch energised 1,000ohm field with transformer, require recentring, 7/6; mains transformer, 280-0-280volts 80mills, 6.3volt 3amp, 5volt 2amp screened pri. drop thru chassis type, primary input 220 and 240 volts, 13/6; write for lists.—Cohen, 67, Raleigh Ave., Hayes, Middx. [2478

45mc/s television strip (5VR91) with 20 other valves, R3553 £3/10, R3515 new and boxed 21 valves, etc., 13.5mc/s IF strip, £4; R1124 6 Brimar valves, etc., 20/-, 2—35/-; all with circuits; modulators (5 KT44 2-U17 or VU111, 1-MH4, etc.), 30/-, 2—50/-; all carriage paid; C.R.T., 1¼-inch screen VLS 492AG new and boxed, suitable for small oscilloscope with data, 17/6 post paid; s.a.e. particulars.—G. R. Adcock, Norwich Rd., Watton, Norfolk. [2451

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TELRAD ELECTRONICS, 70, Church Rd., Upper Norwood, London, S.E.19.—Write, call or 'phone Livingstone 4879 for television components to W.W. or E.E. design, E.E. chassis fitted with v/holders, coil formers, sockets and screens, vision 22/6, sound 18/9; t/base, 17/6; power, 25/-; deflector coil ass, line o.p. trans and focus coil ass, 32/6 each; gantrys, straps and control panel, 10/-; 9in tube masks, cream 11/-, black 10/-; everything for television, radio and amp constructor. [2572

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SUPPRESSORS which really work, positively best h.f. stoppers available, 4-section cast case, dust cores, 16 s.w.g., 4 0.1mfd conds, 5/9; new vitreous resistors, 1½ to 75K ohms, 30 and 75w, 1/6; 100 and 200w, 2/-; selenium bridge rectifiers, 2d per watt, viz., 24v 1a 4/-, 5a £1; ¼a 300v 12/6, 1,500v 62/6; chargers, 24v 6a, met. rect, 2 meters 3 switches, etc, £4; bakelite t.r.f. midgets, 135/-; 750v wkg oil conds, 10+8 mfd 3/9, 8mfd 3/-; 0.1 bake tube, 0.5 1,000v, 1mfd 250v, 2mfd 250v, 2½×2in, all 5/6 doz; 250v 5a s.p. switches, panel lamps, 100ohm preset potrs, all 5/6 doz; enclosed holders, 2 5a fuses, 1/-; 4-way ditto, 1/3; 20-32a overload releases, 1/-; block connectors, 2-way 7d, 4-way 9d; 6oz 33 s.w.g. en. wire, 1/3; screened inst. cases, 11×7¾×8¾, 2/4, all post free, no c.o.d.—69, Allerton Grange Way, Leeds, 7. Tel. 66146.

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FERRANTI 7.5kva moving coil voltage regulators, input 200-250v +8% to −12%, 45 to 66cps, output 200-250v ±½%, frequency compensated, as new and unused, with handbook, offered at a fraction of list price to clear; (Herts). —Box 3239. [2558

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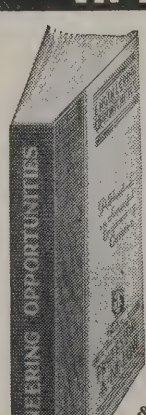

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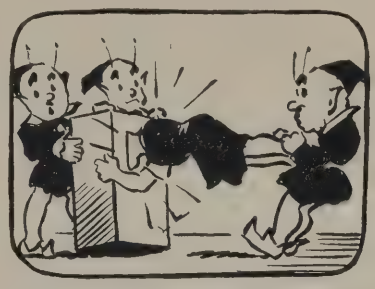

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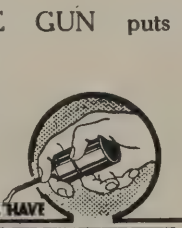

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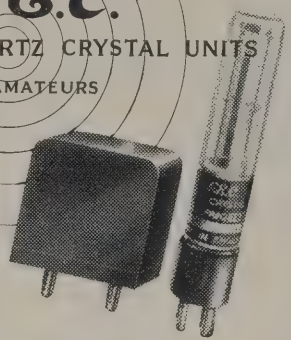

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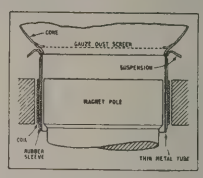

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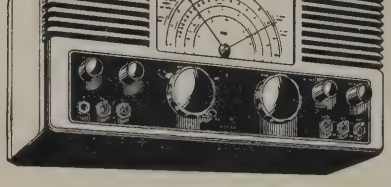

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TELEVISION service engineer required, Bedford Station of National Organisation; exceptional opportunity right man.—Box 3242.

GLASSBLOWER required for research laboratories; all round experience in hard and soft glasses, including lathe work essential. —Apply in person or write to Personnel Department, E.M.I., Ltd., Blyth Rd., Hayes, Middx.

RADIO draughtsmen required by large light engineering company, North London; applicants with knowledge of electronics equipment design preferred, but practical shop and drawing office experience essential.—Write Box 2229.

SENIOR mechanical designer with experience of electro-mechanisms for work on industrial electronic equipment in the Midlands; salary range £600-£1,000.—Details of age, qualifications and exp. quoting ref. D.O.23, to Box 2233.

A LARGE engineering group requires draughtsmen of senior and junior grades in several parts of the country.—Men with sound electrical or mechanical drawing office experience should apply to Box 1933 All replies are acknowledged. [1960

DEVELOPMENT engineer wanted, with experience in radio test equipment, good pay and prospects.—Write, giving full particulars of experience and salary required, to Taylor Electrical Instruments, Ltd., Montrose Avenue, Slough, Bucks. 2466

SENIOR design draughtsman required for work in connection with commercial radio receivers and electronic equipment.—Write, giving full particulars of experience, salary, etc., to the Labour Manager, Bush Radio, Ltd., Power Rd., Chiswick, W.4. [2005

PRODUCTION engineering research association requires instrument designer with wide electrical and mechanical experience.—Applications giving full details, including salary required, to Secretary, Staveley Lodge, Melton Mowbray, Leics. [2411

FIRST-CLASS mechanical designers required; men with experience in the design of domestic radio receivers and components preferred.—Applications in writing to Personnel Department, Murphy Radio, Ltd., Welwyn Garden City, Herts. [2481

AN engineer with considerable experience in pulse circuitry technique required immediately; please give full details of experience to date and state salary required.—Application form from The Staff Manager, Ferranti, Ltd., Hollinwood, Lancs. [2406

SENIOR and junior, experienced development, research engineers and draughtsmen required for radio, television, electronics, radar, speakers; preference B.Sc., H.N.C.; also testers, inspectors, repairers, service engineers, etc.—Technical Employment Agency, 179, Clapham Rd., S.W.9. (Brixton 3487). [2556

PHYSICIST required for research on the magnetic properties of powder metallurgy products; applicants must hold an Honours Degree and should possess special knowledge of magnetic measurements; the post is in Northamptonshire; salary according to qualifications and experience. —Please reply to Box 2924. [2403

FULLY qualified electronic engineer required by hearing aid manufacturers 50 miles from London; able to carry through development to production stage; sound technical background and practical experience essential.—Apply in writing, stating qualifications and salary required, to Box 3107. [2473

TECHNICAL assistant required by S.W. London firm, aged approximately 25 with B.Sc. (Eng.), should have had some experience of electronic development work.—Write, giving full details of age, experience, qualifications and salary required, to Box 635, c/o J. G. King & Son, 150, Fleet St., London, E.C.4. [2445

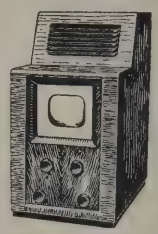
INTERNATIONAL Company has two vacancies for radio/radar engineering instructors in Karachi; applicants preferably single should have recent teaching experience and knowledge of civil airline radio/radar equipment air and ground; salaries £600 and £500 p.a., plus ample allowances.—Particulars to Box 2925. [2408

CORRESPONDENCE clerk required by leading manufacturer of radio and electronic components; essential qualifications are ability to handle voluminous and varied correspondence, rudimentary technical knowledge and similar recent experience.—Write, stating age, experience and salary required, to Box 3135.

RADIO service engineer required for provincial firm of high standing, must be of first class technical standard and have had considerable practical experience, knowledge of television an advantage; wage according to ability and confirmed after one months' probation.—Apply to Barnes & Avis, Ltd., 140-1, Friar St., Reading.

RADIO technicians required at Ongar W/T transmitting station; candidates should have had practical experience of operating high power transmitting apparatus; preference given residents North Weald and district.—Apply in writing to Manager, W/T Station, Cable & Wireless, Ltd., North Weald, Epping, Essex, giving qualifications and experience. [2436

APPLICATIONS are invited by a company situated within a 25 miles radius of London for the position of senior engineer to take charge of a laboratory engaged upon design, development and application of R.F. heating; applicants should have an Honours Degree in science and previous experience of the work upon which the laboratory is engaged; salary £700 to £1,000 p.a., according to qualifications —Applications should be addressed to Box 2923.



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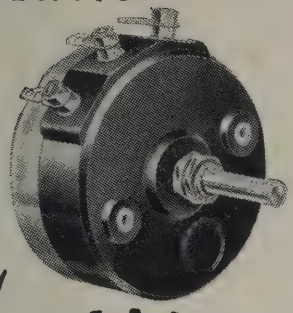

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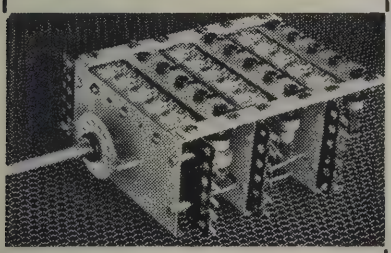

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VACANCIES for draughtsman/designer (mechanical) and junior television development engineers.—Write, Personnel Manager, Sobell Industries, Ltd., Langley Park, Langley, Bucks, stating age, qualifications, experience, and salary required. [2426

YOUNG man required, energetic, adaptable and imaginative salesman to give demonstrations of high fidelity amplifiers, to deal with correspondence and advertising, salary and commission basis giving ample scope, London area.—Box A.C. 35106, Samson Clarks, 57-61, Mortimer St., W.1. [2441

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A QUALIFIED engineer, experienced in the design of teleprinter and magnetic recording technique, required to participate in a development project of considerable interest; applications should give details of academic training and subsequent experience, together with salary required.—Application form from, The Staff Manager, Ferranti, Ltd., Hollinwood, Lancs.

ELECTRONIC engineer required with a degree or equivalent technical qualification and design experience of centimetre wave transmitters, receivers and test equipment; a vacancy also exists for a general electronic circuit engineer.—Write indicating salary required, etc., to Personnel Manager, The Sperry Gyroscope Co., Ltd., Great West Rd., Brentford, Middlesex.

DRAUGHTSMAN, vacancy London for young draughtsman with general experience precision light mechanisms or instruments; electronic knowledge an advantage, but applicant with interest in design of electro-mechanical product preferred; good practical and technical training; state age and full details, experience and technical qualifications, also salary required. —Box 3197. [2550

SENIOR development engineers required, must have good technical training, preferably with Hons. Degree in Physics or Engineering and radio laboratory experience; able to carry through development, with assistants, to production stage; salary up to £800 according to qualifications.—Apply in writing to Personnel Department, Murphy Radio, Ltd., Welwyn Garden City, Herts. [2105

DEVELOPMENT engineer required to work on experimental types of cathode ray tubes; applicants should possess a physics degree and have had practical experience in the design, development and manufacture of cathode ray tubes.—Apply giving details of qualifications, experience and salary required, to Personnel Department C/F., E.M.I. Factories, Ltd., Blyth Rd., Hayes, Middx. [2438

DESIGN draughtsmen are required by the English Electric Co., Ltd., Stafford, for research and development work on electronic equipment; applicants must have higher national certificate or equivalent, and shop experience; salary according to experience.—Send full details to Central Personnel Services, English Electric Co., Ltd., Queens House, Kingsway, W.C.2, quoting Ref. DO.25. [2192

RADIO operator mechanic required for radio station situated fifteen miles north of London; applicant should be able to receive morse at 30/35 w.p.m. using typewriter, and possess good all-round technical knowledge particularly communication receivers, experience in teleprinter operation and maintenance an advantage, shift duties, salary according to qualifications.—Write, stating exp., qualifications.—Box 3102.

APPLICATIONS are invited from engineering and physics graduates and from designer-draughtsmen with a degree or equivalent qualifications, by the Research Laboratories of the General Electric Co., Ltd., East Lane, North Wembley, Middlesex, for work on telecommunications equipment; experience of pulse and wave form techniques an advantage.—Apply to the Director, stating age, academic record and exp.

JUNIOR engineer required for examination and analysis of cathode ray tubes; previous experience desirable but not essential, providing suitable technical background; vacancy offers good prospects for enthusiastic junior and facilities extended for furthering technical training.—Apply giving age, details of experience if any, together with technical qualifications, to Personnel Department, C/F., E.M.I. Factories, Ltd., Blyth Rd., Hayes, Middx. [2439

MAINTENANCE engineers required by S.W. London firm, successful applicants should have higher National Certificate or equivalent and some experience in service and maintenance of electrical control equipment with particular reference to programme controllers and general electrical furnace control equipment, age 25-30. —Write, giving details of age, qualifications, experience and salary required, to Box 634, c/o J. G. King & Son, 150, Fleet St., London, E.C.4.

ELECTRONIC engineers with honours degree or equivalent are required for research and advanced development work by the Nelson Research Laboratories, English Electric Co., Ltd., Stafford; preference will be given to men with sound electrical engineering experience; salary according to qualifications.—Apply by letter to Chief, Administration, Nelson Research Laboratories, English Electric Co., Ltd., Stafford, stating age, experience and academic qualifications.

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LARGE electrical organisation requires an assistant engineer, capable of writing specifications, dealing with tenders and contracts for sound installations; design work on special amplifier and electronic circuits; successful applicant would be required to assist in special surveys of factories, etc.; some general experience of office routine; B.Sc. and/or A.M.I.E.E. qualifications preferred, but not essential.—Write, giving full details as to age, previous experience and salary required, to Box 2231. [2142

RADIO and electronic senior engineer required by leading firm of manufacturers; applicants must have extensive practical experience in technical development of electronic equipment, with special knowledge of circuit techniques; post is within 20 miles' radius of London and is progressive; recognised qualifications are desirable, but practical ability is the essential factor, age preferably not over 35 years; fares paid for interview; salary approx. £450 p.a., according to qualifications and experience. —Written applications, giving date of birth, full details of qualifications and experience, etc., and quoting reference 439M, should be addressed to Regional Appointments Office, Ministry of Labour & Nat. Service, 23, Valpy St., Reading.

THE Admiralty invite applications for appointment as temporary draughtsmen (mechanical, electrical, electronic, constructional) at research and development establishments situated in various parts of England and Scotland (principally southern England); candidates must be British subjects and have served an engineering apprenticeship or had equivalent workshop experience; if 23 years of age or over, they must possess the Higher National Certificate (or equivalent); if under 23 they should possess the Ordinary National Certificate (or equivalent); drawing office experience in the preparation of designs of components and complete projects desirable; experience connected with experimental and development work will be additional advantage; salary will be assessed on age and experience within the range of £283—£440 rising to £525 according to age, experience and location of employment; appointments will be on temporary basis but with an opportunity, which is expected will arise within 12 months, to compete for established appointment; successful applicants will be liable to appointment to any of the establishments concerned.—Applications should be sent to C.E.II (Room 88), Empire Hotel, Admiralty, Bath; original testimonials should not be forwarded, only candidates for interview will be advised. [2432

B.B.C. invites applications for a senior post in the Television Section of the Research Department at Kingswood, Surrey; candidates must possess a University Honours degree in electrical engineering or physics, and must have a sound knowledge of telecommunications theory; they must also have a sound knowledge and practical experience of modern television; knowledge and experience of the optical and colour problems involved in television, and of the workshop techniques involved in the construction of electrical and optical apparatus are very desirable; experience of laboratory vacuum plant and a knowledge of photo-electricity are also desirable. The successful applicant will be expected to show initiative and take a leading part in research work in television, especially that on high definition and colour; such work will include the development of experimental monochrome and colour television apparatus, and on ancilliary equipment; it will also involve the devising and carrying out of subjective and objective appraisal tests; copies of any original papers should accompany applications for this post; the salary is in a grade rising by annual increments of £60 to a maximum of £1,360 per annum.—Applications, stating age, qualifications and experience, should reach the Engineering Establishment Officer, Broadcasting House, London, W.1, within 7 days of the appearance of this advertisement. [2443

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RADIO engineer (26), grad. Brit. I.R.E., City and Guilds final, seeks progressive post in industry; N.W. England preferred.—Box 3195.

DEVELOPMENT engineer, age 23, first-class C. & G. IV radio, 5 yrs. lab. experience, seeks progressive position in North London area. —Box 3194. [2543

RADIO engineer (28) requires progressive post London or S. England; qualific. equiv. C. & G. IV, matric.; exp. V.H.F. technique from installation to development.—Box 3193.

TECHNICIAN, age 27, married, three years as transmitter engineer in B.B.C., five years in R.A.F. as radio mechanic and operator/air crew, industrial experience, seeks post as technician in research or development laboratory; prospects more important than pay.—Box 3104.

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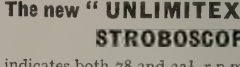

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INDEX TO ADVERTISERS

	PAGE
A.A. Tools	72
A.B. Metal Products, Ltd.	70
Acoustical Mfg. Co., Ltd.	40
Ad. Auriema Inc.	20
Adcola Products, Ltd.	66
Advance Components, Ltd.	10
Aerialite, Ltd.	14
Airmec Laboratories, Ltd.	49
Allan, Richard, Radio, Ltd.	52
Allen Components, Ltd.	69
Armstrong Wireless & Television Co., Ltd.	57
Ashworth, H.	72
Atkins, H. C., Laboratories	52
Austin Mills, Ltd.	70
Automatic Coil Winder & Electrical Equipt. Co., Ltd.	1
A.W.F. Radio Products, Ltd.	56
Barker, A. C.	66
Belling & Lee, Ltd.	41
Berger, Lewis & Sons, Ltd.	51
Bird, S. S., & Sons, Ltd.	16
Birmingham Sound Reproducers, Ltd.	47
Brierley, J. H. (Gramophones & Recordings), Ltd.	16
Brighton Tele-Services	72
Britain, C. (Radio), Ltd.	62
British Communications Corpn., Ltd.	16
British Institute of Engineering Technology	62, 67, 70
British Insulated Callender's Cables, Ltd.	Cover ii
British National Radio School	65
British Physical Laboratories	24
Brown, S. G., Ltd.	20
Bulgin, A. F., & Co., Ltd.	Edit. 509
Bull, J., & Sons	61
Bull's Ex-Govt. Depot	68
Bullers, Ltd.	49
Burgoyne Eng. Co., Ltd.	6
Candler System Co.	66
Charles Amplifiers, Ltd.	54
Chloride Electrical Storage, Co., Ltd.	4
Cinema-Television, Ltd.	34
Clydesdale Supply Co., Ltd.	64
Collaro, Ltd.	23
Cosmocord, Ltd.	71
Coulphone Radio	46
Coventry Radio	69
Davis, Alec	22
Denco (Clacton), Ltd.	32
Descutter Bros., Ltd.	36
Drayton Regulator & Instrument Co., Ltd.	30
Dubilier Condenser Co. (1925), Ltd.	9
Dupley Electronics, Ltd.	62
Edison Swan Electric Co., Ltd.	11, 33
Electradix Radios	59
Electric & Musical Industries, Ltd.	14, 44
Electro Technical Assemblies	60
Electronic Instruments, Ltd.	18
Elmsleigh Radio Co.	70
Erie Resistor, Ltd.	Cover iii
Erskine Laboratories, Ltd.	53
Eta Tool Co. (Leicester), Ltd.	22
Factor, J., Ltd.	70
Film Industries, Ltd.	Edit. 503
Fitton, R. N., Ltd.	48
Fluxite, Ltd.	65
Forrest, H. W.	72
Frith Radiocraft, Ltd.	48
Furzehill Laboratories, Ltd.	20
Galpins	63
Gardners Radio, Ltd.	42
General Electric Co., Ltd.	7, 32
General Lamination Products, Ltd.	26
Goodmans Industries, Ltd.	2
Gray, A., Ltd.	54
Hadley Bros., Ltd.	5
Hartley, H. A. Co., Ltd.	56
Haynes Radio, Ltd.	68
Henley's W. T., Telegraph Works Co., Ltd.	58
Henry's	69
Hill & Churchill, Ltd.	68
Hivac, Ltd.	50
Holborow & Co.	70
Holsun Batteries, Ltd.	12
Holt, Stan	62
Hunt, A. H., Ltd.	35
Imhof, A., Ltd.	Edit. 505
Industrial Electronics	50
International Correspondence School, Ltd.	46
Jackson Bros. (London), Ltd.	24
Johnson, Matthey & Co., Ltd.	27
Kerry's (Gt. Britain), Ltd.	22
Lasky's Radio	71
Leak, H. J. & Co., Ltd.	13
Linton, H. H., & Co., Ltd.	59
London Central Radio Stores	25
London Radio Supply Co.	64
Lowther Mfg. Co.	65
Lustraphone, Ltd.	54
Lyncar Laboratories	68
Mail Order Supply Co.	52
Marconi Instruments, Ltd	28
Marconi Wireless Telegraphy Co., Ltd.	12
Masteradio, Ltd.	23
McMichael Radio, Ltd.	48
McMurdo Instrument Co., Ltd.	58
Metro Pex, Ltd.	8
Midland Instrument Co.	71
Modern Book Co.	66
Motherwell Machinery & Scrap Co., Ltd.	67
M.R. Supplies, Ltd.	28
Mullard Electronic Products, Ltd.	8, 38
Multicore Solders, Ltd.	Cover iv
Oliver Pell Control, Ltd.	34
Oxley Developments Co., Ltd.	54
Parmeko	40
Partridge Transformers, Ltd.	55
Peerless Radio Ltd.	60
Pennine Amplifiers	67
Philips Electrical, Ltd.	44
Pill, G. N., & Partners	68
Premier Radio Co.	31
Quartz Crystal Co., Ltd	64
Radford, A. H.	66
Radio-Electronics, Ltd.	70
Radiomart (B'ham), Ltd.	26
Radiospares	64
Rediffusion, Ltd.	30
Reliance Mfg. Co. (Southwark), Ltd.	69
Reproducers & Amplifiers, Ltd.	10
R.M. Electric, Ltd.	6
Rogers Developments Co.	68
Rollet, H., & Co., Ltd.	72
Runbaken	70
Salford Electrical Instruments, Ltd.	66
Sangamo Weston, Ltd.	35
Savage Transformers, Ltd.	18
Savage, W. Bryan, Ltd.	60
Simon Sound Service	2
Sound Rentals, Ltd.	14
Sound Sales, Ltd.	44
Southern Radio Supply, Ltd.	60
Southern Trade Services, Ltd.	68
Stability Radio Components, Ltd.	46
Standard Electrical Eng. Co.	29
Standard Telephones & Cables, Ltd.	39, 45
Steatite & Porcelain Products, Ltd.	21
Stern Radio, Ltd.	67
Stewart Transformers, Ltd.	24
Stratton & Co., Ltd.	26
Taylor Electrical Instruments, Ltd.	51
Telegraph Condenser Co., Ltd.	15
Teleradio Co.	62
Tele-Radio (1943), Ltd.	32
Thornton, W. & J. R. (Woodturners), Ltd.	30
Transradio, Ltd.	52
Trix Electrical Co., Ltd.	Edit. 501
Truvox Eng. Co., Ltd.	17
T. & C. Radio College	58
United Insulator Co., Ltd.	3
Universal Electrical Instruments Corpn.	71
University Radio, Ltd.	70
Vallance & Davison, Ltd.	50
Valradio	54
Vitavox, Ltd.	42
Voigt Patents, Ltd.	70
Vortexion, Ltd.	43
Ward, Chas. F.	64
Watts, M., & Co.	56
Wayne Kerr Labs., Ltd., The	47
Webb's Radio	19
Wells & Co., Ltd.	53
Westinghouse Brake & Signal Co., Ltd.	4
West, Spencer	70
Weymouth Radio Mfg. Co., Ltd., The	64
Wharfedale Wireless Works	34
White'ey Electrical Radio Co., Ltd.	18
Wilkins & Wright, Ltd.	68
Wilkinson, L.	54
Wilson, M., Ltd.	Edit. 507
Wireless Supplies Unltd.	70
Wright & Weaire, Ltd.	37

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